GUADALUPE RIVER WATERSHED MERCURY TMDL PROJECT

AGREEMENT NO. A2643G

TECHNICAL MEMORANDUM 5.3.1

DRAFT DATA COLLECTION REPORT

PART I: WET SEASON SAMPLING

Prepared for

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614

Prepared by

TETRA TECH, INC.
3746 Mt. Diablo Blvd., Suite 300
Lafayette, CA 94549-3681

June 23, 2004

TABLE OF CONTENTS

1.0 Introduction 1-1
1.1 Sampling Elements 1-2
1.2 Guide to the Data Collection Report Organization 1-3
2.0 Sampling and Laboratory Analysis Methods 2-1
2.1 Water Column Samples 2-1
2.2 Sediment Sampling Procedures 2-2
2.3 Parameters and Laboratory Analysis Methods 2-3
3.0 Element 1–Runoff to Reservoirs 3-1
3.1 Purpose and Design of Sampling Element 1 3-1
3.2 Sample Results: Tributaries to Reservoirs 3-5
3.3 Comparison of Results for Tributaries 3-13
3.4 Assessment of Data Quality and Constraints 3-17
3.5 Comparison with Previous Data 3-19
4.0 Element 2–Erosion and Loads to Streams Draining the Historic Mining Areas 4-1
4.1 Purpose and Sampling Design: Element 2 4-1
4.2 Water Column Samples 4-5
4.3 Assessment of Data Quality and Constraints 4-15
4.4 Comparison with Previous Water Data 4-15
5.0 Elements 3 & 4–Mercury Contribution from Other Subwatersheds and from Guadalupe River 5-1
5.1 Purpose and Sampling Design: Elements 3 and 4 5-1
5.2 Water Column Sample Results 5-7
5.3 Assessment of Data Quality and Constraints 5-26
5.4 Comparison with Previous Water Data 5-28
6.0 Sediment Sampling 6-1
6.1 Purpose and Design of Sediment Sampling 6-1
6.2 Sediment Sample Results 6-8
6.3 Assessment of Data Quality and Constraints 6-22
6.4 Comparison with Previous Sediment Data 6-24
7.0 Hydrology for Estimating Mercury Loads 7-1

7.1 Precipitation 7-1
7.2 Gaged Flows 7-2
7.3 Modeled Flows 7-3
7.4 Dates of Wet Weather Sampling 7-6
7.5 Conclusions 7-6
8.0 Mercury Load Estimates 8-1
8.1 Relating Flow to Total Suspended Solids 8-4
8.2 Relating Total Mercury to TSS 8-6
8.3 Relating Dissolved and Methylmercury to Total Mercury 8-8
8.4 Calculating Daily Flows 8-11
8.5 Estimating Non-Point Mercury Loads 8-12
8.6 Loads to Reservoirs 8-13
8.7 Reservoir Loads to Downstream Creeks 8-13
8.8 Calculating Transported Loads Throughout the Watershed 8-13
8.9 Uncertainty Analysis 8-21
8.10 Conclusions 8-25
9.0 Recommendations from the Wet Weather Sampling 9-1
10.0 References 10-1
Appendix A Sampling Locations A-1
Appendix B QA/QC Summary B-1
Appendix C 2004 Mercury Data C-1
C.1 Aqueous Mercury Speciation in Guadalupe River System, Winter 2004 ..... C-1
C.2 Aqueous Mercury Speciation in Guadalupe River System, Spring 2004 ..... C-1
C.3 Mercury Speciation in Guadalupe River Sediments C-1
C.4 Sequential Selective Extractions of Mercury in Guadalupe River Sediments C-1
C.5 Bioavailable Hg of Coarse Inhomogeneous Material C-1
C.6 Total Hg in Ground and Size Fractioned Sediments C-1
C.7 Total Hg in Guadalupe River Sediments Digestion Comparison C-1

LIST OF TABLES

Table 2-1 Chemical Parameters and Laboratory Analytical Methods for Synoptic Survey for Guadalupe TMDL Project 2-4

Table 3-1 Description of Sampling Stations and Rationale for Element 1: Runoff to Reservoirs 3-3

Table 3-2. Flows for Reservoir Tributaries and Outlets, Wet Season Sampling 2004 3-6

Table 3-3. Aqueous Mercury Speciation in Reservoir Tributaries and Outlets, Wet Season 2004 3-8

Table 3-4. Field Parameters for Reservoir Tributaries and Outlets, Wet Season Sampling 2004 3-14

Table 3-5. Total Mercury Concentrations in Mining Area (SCPD, 2003) 3-20

Table 3-6 Water Quality and Mercury in Creek Water Samples from Synoptic Survey3-21

Table 3-7. Sampling Results for Almaden and Lexington Reservoir Outlets from LAS . 3-25

Table 4-1. Description of Sampling Stations and Rationale for Element 2: Erosion in Alamitos and Guadalupe Creeks 4-2

Table 4-2. Flow Measurements for Element 2 Sampling Locations, Wet Season 2004... 4-6

Table 4-3. Aqueous Mercury Speciation in Guadalupe and Alamitos Creeks and Tributaries, Wet Season 2004 4-7

Table 4-4. Field Measurements for Element 2 Water Samples, Wet Season 2004..... 4-9

Table 4-5. Comparison of Dry and Wet Season Results for Alamitos and Guadalupe Creeks..... 4-17

Table 5-1. Description of Sampling Stations and Rationale for Element 3: Hg from Other Watersheds to Guadalupe River..... 5-2

Table 5-2. Description of Sampling Stations and Rationale for Element 4: Hg Transport in Guadalupe River..... 5-6

Table 5-3. Flow Measurements at Elements 3 and 4 Sampling Locations, Wet Season 2004 5-8
Table 5-4. Aqueous Mercury Speciation in Guadalupe River System, Wet Season 20045-11
Table 5-5. Field Measurements for Element 3 and 4 Water Samples, Wet Season 20045-15
Table 5-6 Comparison of Dry and Wet Weather Water Samples for Mercury 5-29
Table 5-7. Mercury in Selected Stations the 2003 Synoptic Survey 5-29
Table 6-1. Description of Sediment Sampling Stations and Rationale for Sediment Samples in Guadalupe River and Upstream 6-2
Table 6-2. Sediment Sampling Locations 6-3
Table 6-3. Mercury Speciation in Sediments from Guadalupe River and Selected Tributaries..... 6-10
Table 6-4. Sulfate and Sulfide Concentrations in Sediment Samples 6-12
Table 6-5. Major Grain Size in Selected Sediments..... 6-19
Table 6-6. Total Mercury Concentration by Grain Size Fraction..... 6-20
Table 6-7. Sequential Selective Extractions of Mercury in Guadalupe River Sediments6-22
Table 6-8. Sediment Sample Results from July 2003 in Vicinity of 2004 Locations 6-25
Table 6-9. Sediment Sample Results from October 2000 in Vicinity of 2004 Locations6-27
Table 8-1. Classification of stations for developing flow and concentration correlations.8-3
Table 8-2. Intercepts, slopes, and correlation coefficients for the regressions between flow and total suspended solids for different water body groups. 8-5
Table 8-3. Intercepts, slopes, and correlation coefficients for the regressions between total mercury and dissolved mercury for different water body groups. 8-10
Table 8-4. Intercepts, slopes, and correlation coefficients for the regressions between total mercury and methylmercury for different water body groups. 8-11
Table 8-5. Mercury Loads in Guadalupe River Watershed (in grams over the wet season, 10/1/2003 to 5/31/2004)..... 8-15

LIST OF FIGURES

Figure ES-1. Rainfall measured at selected gages during the period of sampling for this study. ix

Figure ES-2. Station locations for water (blue symbols) and sediment (red symbols) samples for the wet weather data collection. ix

Figure ES-3. Graphical depiction of total mercury transport pathways through the Guadalupe River Watershed. xii

Figure 3-1. Sampling Locations for Element 1: Runoff to Reservoir 3-2

Figure 3-2. Total and dissolved mercury in reservoir watershed water samples. 3-11

Figure 3-3. Methylmercury in reservoir outlet and canal water samples. 3-12

Figure 3-4. Comparison of mercury species in tributaries to the reservoirs 3-16

Figure 3-5. Box Plots for reservoir tributaries a) total mercury and b) methylmercury ... 3-18

Figure 3-6. Reservoir outlet samples: a) suspended solids, b) total mercury, c) methylmercury 3-23

Figure 3-7. Total mercury and methylmercury versus suspended solids in reservoir outlet samples 3-24

Figure 4-1. Sampling Locations for Element 2: Erosion and Tributary loads in stream drainage historic mining areas 4-4

Figure 4-2. Total and dissolved mercury concentrations in Alamitos and Guadalupe Creeks and tributaries. 4-12

Figure 4-3. Methylmercury concentrations in Alamitos and Guadalupe Creeks and tributaries. 4-14

Figure 4-4. Mercury species along Guadalupe and Alamitos Creeks in April 2004 4-16

Figure 5-1. Sampling Locations for Elements 3 and 4: Guadalupe River and Major Tributaries. 5-3

Figure 5-2. Percent Flow Contributed by Urban Creeks to Guadalupe River at Highway 101 Gauge. 5-10
Figure 5-3. Los Gatos Creek on 2/27/04 at high flow a) at Vasona Dam and b) below on dam 5-18
Figure 5-4. Box Plots Comparing Suspended Sediment, Total and Methylmercury for Urban Creeks and Upstream Tributaries to Guadalupe River. 5-19
Figure 5-5. Comparison of Mercury Species in Urban Creeks in February 2004..... 5-20
Figure 5-6. Total and Dissolved Mercury for Large Storm Event February 26-27, 2004. 5-21
Figure 5-7. Total and Dissolved Mercury for Small Storms – April 2004. 5-22
Figure 5-8. Total and Dissolved Mercury for Non-storm Day March 8, 2004 5-23
Figure 5-9. Comparison of Mercury Species along Guadalupe River..... 5-24
Figure 5-10. Sediment Build-up at the Alamaitos Drop Structure (1/27/04) a) above structure and b) sediment pile below structure. 5-25
Figure 5-11. Box Plots Comparing Suspended Sediment Total and Methyl Mercury for Guadalupe River Main Stem to Inputs. 5-27
Figure 6-1. Sediment Sampling Locations for Wet Season 2004 6-4
Figure 6-2. Aerial photograph of Lake Almaden and vicinity showing gravel bars at mouths of Guadalupe and Alamitos Creeks..... 6-6
Figure 6-3. Box Plots Comparing Bank and Bottom Samples along the Guadalupe River to the Tributaries 6-12
Figure 6-4. Total Mercury and Methylmercury along Guadalupe River 6-13
Figure 6-5. Maximum (a total and b) methylmercury concentrations in bottom sediment6-15
Figure 6-6. Comparison of Total Mercury and methylmercury Concentrations in Sediment Samples (McAbee Creek samples not shown since methylemrcury was not measured.) 6-16
Figure 6-7. Grain Size Distributions for Example Sediment Samples 6-17
Figure 6-8. Comparison of Results from Mercury Bioavailability Tests 6-23
Figure 7-1. Measured rainfall for selected rain gages in the Guadalupe River Watershed. 7-2
Figure 7-2. Measured flow for selected gages in the Guadalupe River Watershed. 7-4
Figure 7-3. Mean daily streamflow in the Guadalupe River at downtown San Jose 7-5
Figure 7-4. Modeled flows, using the Surface Water Assessment Tool (SWAT) for five representative sub-basins within the Guadalupe Watershed. 7-7
Figure 7-5. Rainfall measured at selected gages during the period of sampling for this study. 7-8

Figure 8-1. Relating flow and total suspended solids in different groups of water bodies in the Guadalupe River Watershed. 8-5

Figure 8-2. Comparing the flow-TSS relationship for Guadalupe River obtained in this study to that reported by McKee et al. (2004) where detailed flow and suspended solids measurements were made at one location. 8-6

Figure 8-3. Concentrations of mercury on suspended sediments in water samples collected from different groups of water bodies in the Guadalupe River Watershed. 8-7

Figure 8-4. Relating TSS and total mercury in different groups of water bodies in the Guadalupe River Watershed. 8-8

Figure 8-5 Relating total and dissolved mercury in different groups of water bodies in the Guadalupe River Watershed. 8-9

Figure 8-6. Relating total mercury and methylmercury in different groups of water bodies in the Guadalupe River Watershed. 8-10

Figure 8-7. Graphical depiction of total mercury pathways through the Guadalupe River Watershed. 8-18

Figure 8-8. Graphical depiction of dissolved mercury pathways through the Guadalupe River Watershed. 8-19

Figure 8-9. Graphical depiction of methylmercury pathways through the Guadalupe River Watershed. 8-20

Figure 8-10. Uncertainty in the single-year estimate (2003-2004 wet season) of total mercury loads from Guadalupe River to South San Francisco Bay..... 8-23

Figure 8-11. Year-to-year variability in total wet weather outflows from the Guadalupe River Watershed, based on the USGS gage station just below the confluence of Guadalupe River and Los Gatos Creek..... 8-24

Figure 8-12. Uncertainty in the multi-year estimate (1960-2002 wet seasons) of total mercury loads from Guadalupe River to South San Francisco Bay..... 8-25

EXECUTIVE SUMMARY

This Data Collection Report Part I provides a summary of the results of the wet weather phase of the Guadalupe Watershed Total Maximum Daily Load (TMDL) mercury sampling detailed in the Data Collection Plan (Technical Memorandum 5.3). The primary objective of this effort was to assess the magnitude of mercury loading to the Guadalupe Watershed during the wet season. Rainfall over the entire 2003-2004 wet season was slightly below average, with a return period of 2 years based on historical data. More specifically, during the mid-February to late-April 2004 period over which this sampling was conducted, there was one large storm and several smaller ones (shown in Figure ES-1). Total and methylmercury concentrations in both the particulate and dissolved phases were measured at 55 sampling stations across the watershed between February 26 and April 23, 2004, coincident with major storm events during this period. Total and methylmercury concentrations were measured in sediment from 9 locations and ancillary water quality and sediment measurements were also made. The locations sampled for water and sediments are shown in Figure ES-2. This report describes the data collection efforts, presents the measured values, and summarizes these new data. These data provided the basis for developing the first set of wet weather mercury loading estimates for the Guadalupe Watershed based on field measurements.

The wet weather sampling effort was divided into five conceptually distinct Sampling Elements, as detailed in the Data Collection Plan, and in the interest of consistency, this section summarizes results using the same structure, followed by the estimate of wet weather loads developed using the results of Sampling Elements 1-4, and recommendations for further monitoring and analysis.

Sampling Element 1 Runoff to Reservoirs and Outflows from Reservoirs

Total and methylmercury concentrations in tributaries to reservoirs were measured to determine the loading from areas affected by mining and background sources.

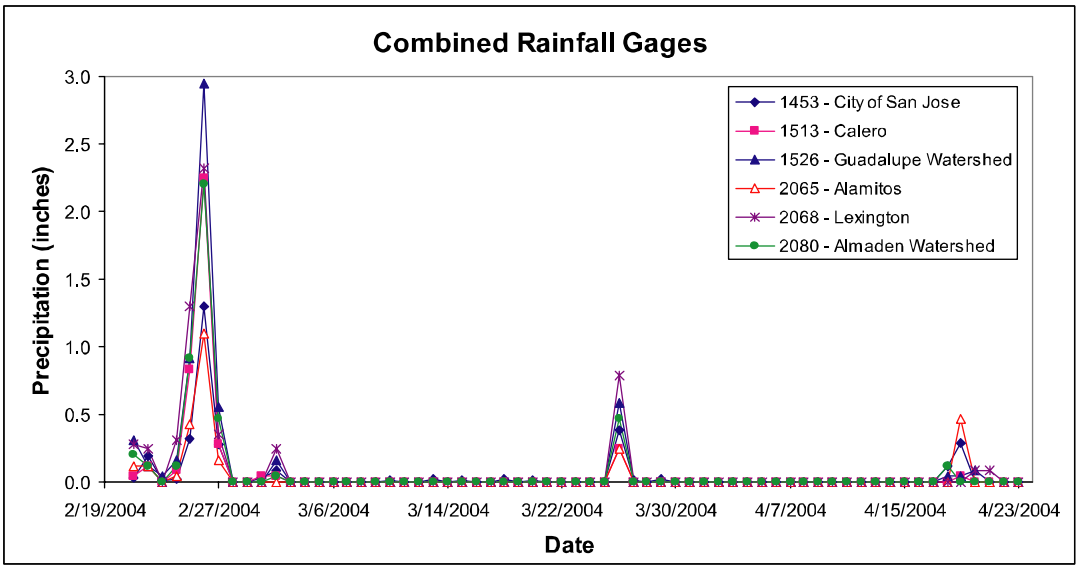


Figure ES-1. Rainfall measured at selected gages during the period of sampling for this study.

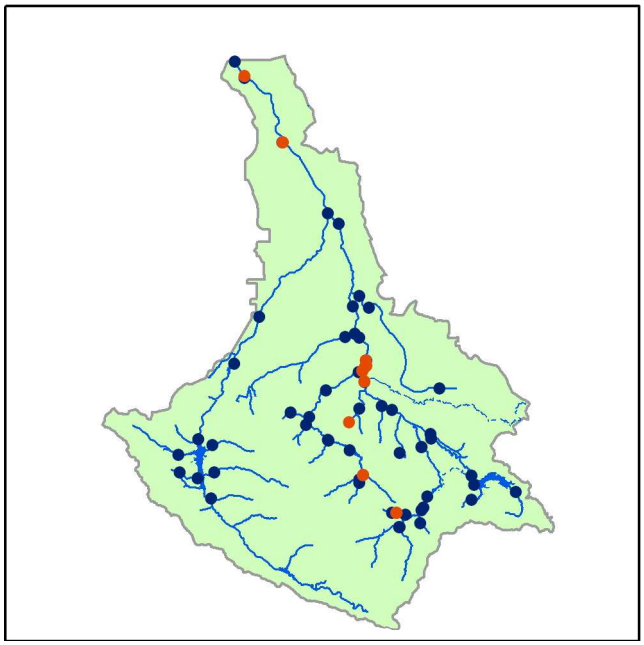


Figure ES-2. Station locations for water (blue symbols) and sediment (red symbols) samples for the wet weather data collection.

Both total and methylmercury concentrations were significantly higher for creeks and reservoir outlets affected by mining. The total mercury concentrations ranged from 1.9 ng/l in a background creek with no mining or other significant anthropogenic influence, to 82 ng/L in a tributary draining the mining areas. The total mercury concentrations in the reservoir outlet samples ranged from 5.9 to 16.4 ng/l in a reservoir with no mining influences (Lexington) to 23.6 to 77.4 ng/L in the reservoirs most affected by mining (Guadalupe and Almaden). The methylmercury concentrations in the tributaries were considerably lower than total mercury and ranged from 0.014 ng/L in a background area to 0.2 ng/L in a creek affected by mining. Methylmercury in the outlets of the reservoirs ranged from 0.05 to 0.07 ng/l in a reservoir with no mining influences (Lexington) to 0.29 to 0.7 ng/L in the reservoirs most affected by mining (Guadalupe and Almaden). Total and methylmercury concentrations were

generally correlated especially when stations were grouped according to the presence or absence of historic mines. The median solid-phase concentrations of mercury in suspended sediments, even in the background areas, were higher than 0.2 mg/kg. This value has been set as a target for sediment concentrations reaching San Francisco Bay from the Guadalupe River Watershed as part of the Bay mercury TMDL, and its exceedance in background areas suggests that this target may be difficult to meet.

Sampling Element 2 Erosion and Loads in Streams Draining the Historic Mining Areas

Total and methylmercury concentrations were measured in Guadalupe and Alamitos Creeks, and their tributaries, which are immediately downstream of the mining areas. Alamitos Creek samples showed some of the highest total mercury concentrations (34.3 ng/l to 139.5 ng/l), with Guadalupe Creek being lower (13.8 to 40.3 ng/l), partly as a result of dilution from non-mining areas. Methylmercury concentrations did not follow a similar pattern, with the two creeks showing similar values: Alamitos Creek samples ranged from 0.26 to 0.55 ng/l and Guadalupe Creek samples from 0.24 to 0.57 ng/l. Concentrations were higher in these larger creeks than in the tributary creeks, indicating erosion of sediment mercury as an internal source.

Sampling Element 3 Mercury Contribution from Other Subwatersheds

Total and methylmercury concentrations were measured in creeks draining the urban portion of the watershed. Concentrations in these creeks were midway between those observed for the background creeks and the mining-affected creeks. Total mercury concentrations ranged from 2 to 30 ng/l, and methylmercury concentrations from 0.004 to 0.36 ng/l. These concentrations show that in some cases, urban concentrations can be significant, and, when the flow volumes are substantial, the loads contributed downstream can be significant compared to the mining loads from the upper portions of the watershed.

Sampling Element 4 Mercury Transport in the Guadalupe River

Total and methylmercury concentrations were measured in water to estimate transport of mercury in the main stem of the Guadalupe River and into San Francisco Bay. Total mercury concentrations in the river, especially during high flows, were generally far higher than in any of the tributary creeks sampled in Elements 1, 2, and 3. Total mercury concentrations ranged from 14.5 to 464.6 ng/l, and were correlated with flows and suspended sediment concentrations. Methylmercury concentrations, on the other hand, were only marginally higher than in many of the tributaries. Concentrations ranged from 0.16 to 0.92 ng/l. The observation of total mercury concentrations higher than in some of the tributaries is indicative of an internal sediment erosion source, as in the creeks downstream of the mining areas.

Sampling Element 5 Mercury in Sediments of the Guadalupe River

Total and methylmercury concentrations were measured in sediments and bank deposits along the main stem of the Guadalupe River, and from other sites in the

upper watershed. Total mercury concentrations showed a clear signal of the presence of mining related wastes including in the downstream portion of the watershed, and at locations where concentrations were elevated they were also highly variable. Mercury in sediment from creeks in the mining area ranged from 180 to 18,655 ng/g and in Guadalupe River they ranged from 64.8 ng/g to 39,279 ng/g. Methylmercury concentrations were orders of magnitude lower, and ranged from 0.05 to 0.14 ng/g in the creeks in the mining area, and from 0.05 to 3.2 ng/g in Guadalupe River.

Wet Weather Loads

Using the mercury concentration data from the Sampling Elements above, and using co-located data on flow and suspended solids, we developed an estimate of mercury loads in the watershed in three forms: total, dissolved, and methylmercury. The load estimates were based on correlations that were developed between flow and suspended solids, between suspended solids and total mercury, and between total mercury and methylmercury. Correlations were developed for groups of stations with similar land cover properties. The loading picture that developed from this analysis showed that, although reservoir outflow loads are significant, they are small compared to runoff loads and internal sediment resuspension loads in Alamitos Creek, Guadalupe River, and Guadalupe Creek. A graphic illustrating the transport of total mercury through the watershed is shown in Figure ES-3. For Guadalupe River, in particular, the estimate of total mercury loads flowing out to San Francisco Bay of nearly 10 kg are more than an order of magnitude greater than the loads flowing in, highlighting the role of sediment resuspension. Given the extremely high concentrations identified in some samples in Element 4 above, the magnitude of the internal load is not surprising. Uncertainty analysis was also performed to estimate the range of possible loads exiting the watershed, both for a single year (the 2003-2004 wet season) and for the period 1960-2002. Because of the tremendous variability in the outflows from the watershed, and the correlation of mercury loads with flows, the multi-year uncertainty is considerably greater, and expected loads range from <10 kg to ~100 kg.

Recommendations

Although the data described in this report added tremendously to our understanding of mercury transport during the wet season in the Guadalupe River Watershed, there still remain some areas where the existing database needs to be expanded. The most significant of these include the continuous monitoring of flow and turbidity in the major creeks draining the mining areas, i.e., Guadalupe and Alamitos Creeks upstream of their confluence with Guadalupe River and the monitoring of flows and mercury concentrations in storm drains in the urban watershed of Guadalupe River. It is also recommended that the new information generated by the wet season sampling and the summer reservoir sampling (to be conducted in summer 2004) should be incorporated into a single revised conceptual model for mercury in the Guadalupe Watershed.

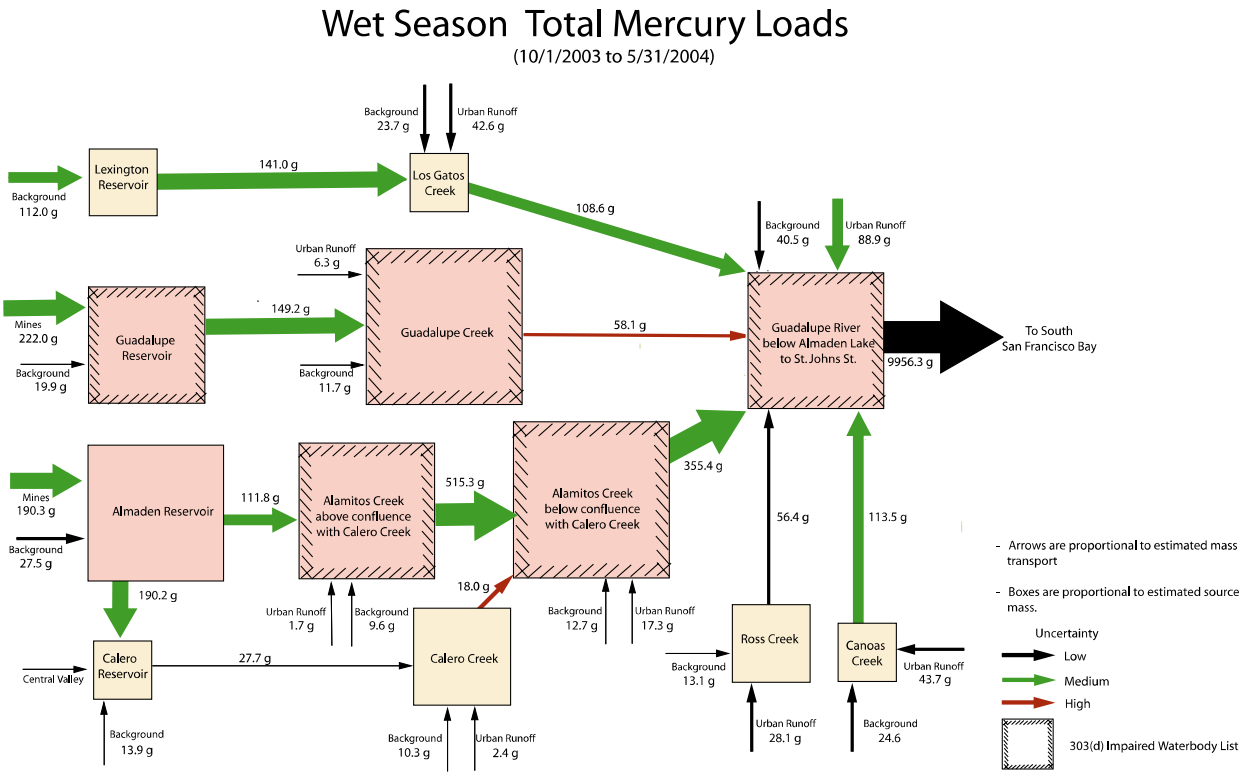


Figure ES-3. Graphical depiction of total mercury transport pathways through the Guadalupe River Watershed.

1.0 INTRODUCTION

A primary objective of the Data Collection Survey was to assess the magnitude of mercury loading to the Guadalupe Watershed during the wet season. Total and methylmercury concentrations in both the particulate and dissolved phases were measured at 55 sampling stations between February 26 and April 23, 2004. Total and methylmercury concentrations were measured in sediment from 9 locations and ancillary water quality and sediment measurements were also made. This report describes the data collection efforts, presents the measured values, and summarizes these new data. Previously, a complementary set of mercury measurements were made at 24 locations in the watershed during the dry season (Tetra Tech, 2003a and 2003b). Together these data provide the basis for developing the first set of mercury loading estimates for the Guadalupe Watershed based on field measurements. This report presents these loading estimates and provides a summary of the uncertainty in our understanding of the hydrologic and geochemical processes affecting mercury loading in the Guadalupe River Watershed.

The Data Collection Report Part 1: Wet Season Sampling Report is the fifth in a series of products being developed in Phase 1 of the TMDL (Total Maximum Daily Load) for Mercury in the Guadalupe River Watershed. Part 2 of this report will present the results of methylmercury production in reservoirs during the 2004 summer stratification period as well as mercury measurements made in fish tissue sampled from reservoirs, creeks and the Guadalupe River. These Data Collection Reports build on the results of the previous work products that have made important contributions to our understanding of the availability and importance of data for the preparation of the TMDL:

- **Preliminary Problem Statement.** *Technical Memorandum 1.2 Preliminary Problem Statement* (Tetra Tech, 2003c) describes the current understanding of the processes or factors that are most relevant to controlling mercury in the watershed. The preparation of this report involved the identification, compilation, and evaluation of a wide range of data describing the environmental setting and mercury sources in the watershed.

- **Synoptic Survey.** *Technical Memorandum 2.1.2 Synoptic Survey Plan* (Tetra Tech, 2003a) and *Technical Memorandum 2.2 Synoptic Survey Report* (Tetra Tech, 2003b) describe the preliminary field sampling effort designed to provide an overview of mercury contamination in the upper watershed. The Synoptic Survey was the first sampling program conducted to provide information specifically relevant to the development of the Mercury TMDL. The sampling emphasized the identification and quantification of mercury sources in the watershed and the identification of locations where transformation of solid phase mercury to bioavailable mercury occur.
- **Conceptual Model.** *Technical Memorandum 4.1 Draft Conceptual Model Report* (Tetra Tech, 2003d) extends the description of our knowledge of existing conditions and describes the biogeochemical processes hypothesized to be controlling mercury transport and fate in the watershed. The mercury conceptual model also provides an up-to-date overview of mercury contamination in the system. Mercury sources, loadings, mercury inventories within the system, and tissue levels within biota are summarized. Water quality, physical data, and significant system characteristics are summarized to describe the variables that affect mercury behavior. The existing data include historical data that have been collected over the past several decades, as well as the results of the Synoptic Survey.
- **Data Collection Plan.** *Technical Memorandum 5.2.3 Data Collection Plan Report* (Tetra Tech, 2004a) describes the data considered essential for development of the TMDL for Mercury in the Guadalupe River Watershed. The sampling plan for the wet season, reservoirs, and fish is included, describing the sampling objectives for the seven major elements, the parameters to be sampled, and the overall sampling approach. The comp[letion of the first five elements of this plan is described in this report.

1.1 SAMPLING ELEMENTS

The five elements of the wet-weather sampling plan are:

Sampling Element 1	**Runoff to Reservoirs** – Total and methylmercury concentrations in tributaries to reservoirs were measured to determine the loading from areas affected by mining and background sources.
Sampling Element 2	**Erosion and Loads to Streams Draining the Historic Mining Areas** – Total and methylmercury concentrations in tributaries to reservoirs were measured in Guadalupe and Alamitos Creeks, and their tributaries, to distinguish internal and external mercury loading.
Sampling Element 3	**Mercury Contribution from Other Subwatersheds** – Total and methylmercury concentrations were measured in creeks draining the urban portion of the watershed.
Sampling Element 4	**Mercury Transport in the Guadalupe River** – Total and methylmercury concentrations in in water were measured to estimate

	transport of mercury in the main stem of the Guadalupe River and into San Francisco Bay.
Sampling Element 5	**Mercury in Sediments of the Guadalupe River** – Total and methylmercury concentrations were measured in sediments and bank deposits along the main stem of the Guadalupe River to quantify loads from this source.

The description of the sampling efforts and the results of each of these elements are reported separately.

1.2 GUIDE TO THE DATA COLLECTION REPORT ORGANIZATION

The results of the 2004 wet-weather data collection efforts are presented in ten chapters.

2.0 Sampling and Analysis Methods.

Description of parameters measured and the sampling and laboratory analysis methods used.

3.0 - 6.0 Sampling and Chemical Analysis Results and Data Analysis.

Sampling elements 1 and 2 are described in separate chapters; while Elements 3 and 4 are included in the same chapter, since an introduction to the urban creek data is needed to fully understand the data from Guadalupe River. Each chapter includes a description of the sampling element, the objectives and hypotheses tested, the sampling results, and an assessment of the use of the data in the TMDL. Data analyses by element in Chapters 3-5 include discussion of the mercury species measured and other parameters in the water samples with comparisons among storm events and locations. Relationships between mercury and suspended solids are presented. In Chapter 5, following the discussion of the results for Elements 3 and 4, other questions that are not specific to one part of the watershed are discussed. Chapter 6 presents all the sediment results.

7.0 Hydrology for Estimating Mercury Loads.

This chapter describes the precipitation that occurred during the sampling period and compares the amounts among locations and to seasonal averages. Flows in the river and gauged creeks are presented for the sampling period and the wet season. Runoff in the tributaries to the reservoirs and Guadalupe and Alamitos Creeks are estimated and compared to field measurements made during the sampling events. The method used to estimate seasonal flows at ungauged locations for the load calculations is also discussed in this section. Suspended solids concentration data for the river and creeks are discussed along with information obtained that pertains to determining the relative transport of suspended and bedded sediments.

8.0 Mercury Load Estimates.

The approach to estimate mercury loads is described and the major input data used are identified. Loads are estimated for total and methylmercury from tributaries to the reservoirs, from other tributaries to Guadalupe and Alamitos Creeks, and from the Guadalupe River.

9.0 Recommendations.

This chapter includes a discussion of any suggested changes to the Preliminary Problem Statement or the Conceptual Model for the Guadalupe River Watershed. Additional data collection is recommended to provide necessary information for the development of the TMDL for the Guadalupe Watershed.

10.0 References.

The references cited in all chapters are presented in Chapter 10.

2.0 SAMPLING AND LABORATORY ANALYSIS METHODS

The wet season sampling program included collection and analysis of water-column samples from reservoir tributaries in the upper Guadalupe watershed, the Guadalupe River, and its tributaries, and the collection and analysis of sediment samples from the Guadalupe River and creeks.

2.1 WATER COLUMN SAMPLES

Measurements of specified water quality parameters (e.g., temperature, pH, conductivity, and dissolved oxygen) were made in the field at each sampling site. Water samples were collected from the river and creeks for laboratory analyses of mercury and ancillary parameters.

Mercury Water Sampling

Field personnel followed the "clean hands-dirty hands" procedures of EPA Method 1669 while collecting the water samples for trace-level mercury, as described in the Synoptic Survey Plan (Tetra Tech, 2003a) and in Appendix B.1 to the Data Collection Plan (Tetra Tech, 2004a). The sample for mercury was the first sample collected. A 500 ml volume of water for mercury samples was collected directly into pre-cleaned Teflon sample bottles. Unfiltered water samples were split into four separate samples for total mercury, unfiltered methylmercury, filtered mercury, and filtered methylmercury analyses in the laboratory. This method makes the species directly comparable, since they come from the same sample. All samples were sent to the laboratory via overnight courier service.

The water sample for filtered mercury and filtered methylmercury was prepared in the laboratory by vacuum filtering through a 0.4 μM disposable nitrocellulose filtration unit, previously found to be non-contaminating for ultra-low level mercury measurements (Bloom, 1994). The filtered sample was poured into a new pre-cleaned sample bottle. The filtered samples were preserved with 0.4 % (v/v) of trace-metals

grade HCl acid. The filtered sample was then split into separate samples to be analyzed for filtered mercury and filtered methylmercury.

Water Sampling for Ancillary Water Quality Parameters

Separate bottles were used to collect water for laboratory analysis of the ancillary parameters. Water samples in the river and creeks were collected using two procedures:

Unpreserved samples – Sample bottles that did not contain preservative (e.g., TSS) were rinsed three times with sample water prior to sample collection, and sealed.

Preserved samples – Sample bottles that contained preservative were not rinsed prior to sample collection. Instead, a clean bottle without preservatives was filled, then used to fill the containers with preservatives. The preservatives used in the water samples were: zinc acetate and NaOH for sulfide.

All bottles were packed with bubble wrap and placed in an insulated cooler with ice equivalent for shipment to the appropriate laboratory under proper chain of custody.

Measurement of Field Parameters

Handheld instruments were used to measure *in-situ* pH, temperature, dissolved oxygen, turbidity, and conductivity in the river and creeks where the water samples were collected. Instruments were calibrated before and after field use as described in the QAPP. The results of these measurements are included in Appendix B.

2.2 SEDIMENT SAMPLING PROCEDURES

Sediment Samples for Mercury

Sediment samples from the top 2 cm were collected for analysis of total mercury using a new, pre-cleaned, disposable polyethylene scoop. The material was placed into specially pre-cleaned 4-oz. Teflon bottles with air-tight-fitting Teflon-lined caps. A new scoop was used for each mercury sampling location. Sediment moisture content was determined so that analytical results could be expressed on a dry and wet weight basis. No non-disposable equipment was used to collect the sediment samples for mercury. Separate sediment samples for methylmercury were obtained using the scoops to place the material in specially pre-cleaned 20 mL glass vials. These vials were only half-filled to avoid breakage after freezing. These vials were immediately placed in a Styrofoam container with dry ice to freeze them immediately; the vials were kept frozen during transit to the laboratory. The mercury and methylmercury sediment samples were packed with bubble wrap and placed in separate coolers for overnight shipment to the laboratory under proper chain of custody. Moisture content was measured in the same sediment sample as the total mercury.

Sediment Samples for Ancillary Parameters

Sediment samples from the bottom and bank of the river or creek channel were collected for analysis of ancillary parameters using disposable polyethylene scoops and placed into an 8-oz HDPE jar for grain-size analyses and in a 4-oz HDPE jar for chemical analyses. The parameters measured in these latter samples were sulfate, sulfide, and moisture content. The sediment samples were then placed in coolers with ice equivalent for delivery to the laboratory. The bottles were packed with bubble wrap and placed in an insulated cooler with ice for delivery to the appropriate laboratory under proper chain of custody.

2.3 PARAMETERS AND LABORATORY ANALYSIS METHODS

Water Samples

Water samples from the river and creeks were analyzed for total and dissolved mercury, and unfiltered methylmercury in 105 samples from 55 locations. The total mercury concentration in the particulate fraction (i.e., the suspended solids) was determined. Filtered methylmercury and the methylmercury concentration in the particulate fraction were measured in 50 water samples from 20 locations. Suspended solids concentrations were measured in all the river and creek water samples. Sulfate and sulfide were measured in water samples from two locations in the Guadalupe River. The laboratory methods for all the parameters in water and sediment are shown in Table 2-1.

Sediment Samples

Sediment samples were collected from five locations along the river and from five creeks. Both bank and bottom samples were collected at the river sites. The total mercury and methylmercury were analyzed, and the percent methylmercury was computed. Moisture content was measured so that the results could be expressed on both a dry and "wet" or as received basis. Sulfate and sulfide were measured in sediment samples from three locations along the Guadalupe River.

Additional analyses were conducted on the sediment samples to determine mercury content in different grain size fractions of selected samples. The sediment samples were digested with an aqua regia solution instead of the method used in the Synoptic Survey, which was HCl then a Teflon bomb with HNO_3 +HF + HCl. Aqua regia consists of one volume of concentrated HNO_3 and three to four parts HCl. The aqua regia digestion is used in EPA method 7471 and for other sediment analysis methods. Tests using an HF digestion were conducted on replicate samples, both ground and unground. The results are discussed in the QA section on sediment in Appendix B.

Sequential extractions using five different solutions were conducted to evaluate the form of the mercury in the sediment and its bioavailability. Coarse sediment samples were leached with one solution, representing the bioavailable fraction. Twelve samples were leached using a five-step sequential extraction procedure to determine

Table 2-1
Chemical Parameters and Laboratory Analytical Methods for Synoptic Survey for Guadalupe TMDL Project

Parameter	EPA Method No.	Units	Reporting Limit
Water			
Total Mercury	1631	ng/L	0.2 ng/L
Dissolved Mercury	1631	ng/L	0.2 ng/L
Methylmercury	1630	ng/L	0.05 ng/L
Filtered Methylmercury	1630	ng/L	0.05 ng/L
Total Suspended Solids	160.2	mg/L	1 mg/L
Sulfate	300 (IC)	mg/L	1mg/L
Sulfide	376.1	mg/L	0.01mg/L
Sediment Samples			
Total Mercury	1631	ng/g	0.5 ng/g
Methylmercury	1630	ng/g	0.2 ng/g
Sulfide	9030	mg/kg	0.5 mg/kg
Sulfate	300	mg/kg	10 mg/kg
Moisture Content	160.3	% by wt	0.01% by wt
Grain Size Distribution	ASTM D4464	% by wt	0.01% by wt

Actual reporting limits achieved for mercury were less.

Field Parameters

Specific conductivity, temperature, dissolved oxygen, pH, and turbidity were measured in the water samples in the field.

the extent of leaching by each solution, which provides an indication of the form of the mercury. The procedure uses a 100:1 liquid-to-solids ratio in 40 mL vials for each step with a leaching time of 18 hours, as described in Bloom et. al., 2003. The extraction steps in order of weakest to strongest are described below:

Step	Extractant	Description	Typical Compounds
F1	DI water	water soluble	$HgCl_2$, $HgSO_4$
F2	pH 2 HCl/HOAc	"stomach acid"	HgO
F3	1N KOH	organo complexed	Hg-humics, Hg_2Cl_2
F4	12N HNO3	strong complexed	mineral lattice, Hg_2Cl_2, Hg^o
F5	aqua regia	cinnabar	HgS, m-HgS, HgSe, HgAu
Sum			total Hg

These extractions can help estimate the fraction of the mercury associated with minerals such as cinnabar and the soluble fraction. The bioavailable fraction is considered to be the sum of steps F1 through F3. For the coarse samples from this sampling program, the F3 solution was used to provide an estimate of bioavailability. The results of these tests are discussed in Section 6.

3.0 ELEMENT 1–RUNOFF TO RESERVOIRS

3.1 PURPOSE AND DESIGN OF SAMPLING ELEMENT 1

The Conceptual Model of the Guadalupe River Watershed (Tetra Tech, 2003d) concluded that runoff from the watershed is potentially a significant source of mercury loading to the reservoirs of the Guadalupe River Watershed. Sampling Element 1 was conducted to address the following question put forward by the Guadalupe Mercury Work Group:

What are the "background" concentrations and loads of mercury to the reservoirs in the watershed?

It has been postulated that the natural geology of the area influences the magnitude of mercury loading in the watershed, and that mercury loading in the mining district is higher than other areas. Thus, Sampling Element 1 addressed two hypotheses:

1. *"Background" (defined as atmospheric deposition plus runoff in non-mercury enriched areas) concentrations of total, dissolved, and methyl mercury in runoff from reservoir watersheds are measurable.*

2. *Mercury concentrations and loads in tributaries that drain mercury-mined areas (Almaden, Calero, and Guadalupe Reservoirs) are higher than non-mined areas in the same watersheds, and these are higher than an area without mercury mining (Lexington Reservoir watershed).*

Sampling Design: Three sampling events were conducted between March 2 and April 20, 2004. Event 1 consisted of sampling four reservoir outlets, 16 of the 20 tributaries to the reservoirs, and the inlet and outlet of Almaden-Calero Canal to characterize the wet season runoff. The sample locations are shown on the map (Figure 3-1). Descriptions of the sampling locations and the rationale for their selection are presented in Table 3-1. A sampling location on Briggs Creek, a tributary to Lexington Reservoir, was added upstream of the planned location to be certain that no backwater effects from the reservoir were present. This sample is designated as

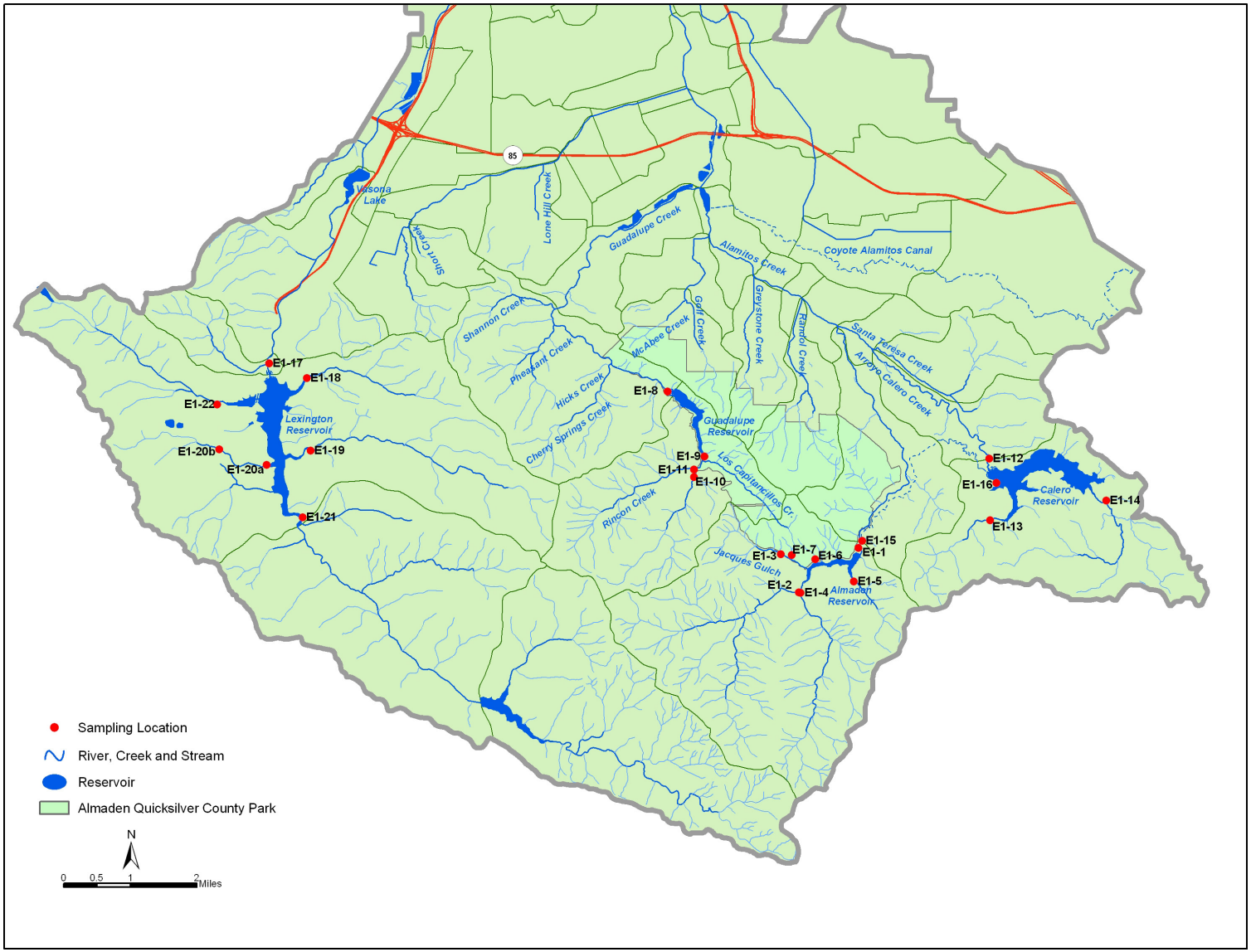


Figure 3-1. Sampling Locations for Element 1: Runoff to Reservoir

Table 3-1
Description of Sampling Stations and Rationale for Element 1: Runoff to Reservoirs

Sampling Site Identifier	Sampling Station Description	Rationale
E1-1	**Almaden Reservoir outlet** (gauged)*	Measure wet weather Hg concentrations to Alamitos Creek and compare to dry weather concentrations.
E1-3	Jacques Gulch above Mine Hill tributary**	Measure wet weather Hg concentrations from non-mined area of Jacques Gulch. Has not been sampled.
E1-7	Mine Hill tributary to Jacques Gulch**	Measure wet weather Hg concentrations to reservoir from creek draining area with mine waste. Collect sediment sample for total Hg, Hg by grain size and Hg bioavailability.
E1-2 E1-4 E1-5	Herbert Creek Barret Canyon Larrabee Gulch	Measure wet weather Hg concentrations to reservoir from background area to compare to estimated load from atmospheric deposition. Sampling creeks entering reservoir allows comparison of external sources of Hg in wet weather to determine if background is elevated due to geologic formations. These creeks have not previously been sampled.
E1-6	W tributary from Mine Hill to reservoir	Measure wet weather Hg concentrations from mined area. Has not been sampled separately.
E1-8	**Guadalupe Reservoir outlet** (gauged)*	Measure wet weather Hg concentrations to Guadalupe Creek and compare to dry weather concentrations.
E1-9	N Los Capitancillos Creek**	Measure wet weather Hg concentrations to reservoir from creek draining area affected by mining. Samples for total Hg on two previous dates show that Hg concentrations were less than for other mine area samples; but Hg was present. MeHg has not been sampled. Collect sediment sample for total Hg, Hg by grain size and Hg bioavailability.
E1-10 E1-11	Upper Guadalupe Creek Rincon Creek	Measure wet weather Hg concentrations to reservoir from background area to compare to estimated load from atmospheric deposition and to load from mining area. These creeks have not been sampled recently, and MeHg has not been measured. Sampling these creeks will show whether Hg sources from geologic formations or past unknown mines are influencing creeks. Hg concentrations from these 2 creeks will be compared to N Los Capitancillos Creek to see if Hg concentrations are similar.

*Sampled three times; ** Sampled two times.

Table 3-1 (continued)
Description of Sampling Stations and Rationale for Element 1: Runoff to Reservoirs

Sampling Site Identifier	Sampling Station Description	Rationale
E1-12	**Calero Reservoir outlet** (gauged)*	Measure wet weather Hg concentrations to Calero Creek and compare to dry weather concentrations.
E1-13	Cherry Canyon	Measure wet weather Hg concentrations to reservoir and compare to estimated load from direct atmospheric deposition and load from Almaden-Calero Canal. These creeks have not previously been sampled; results will show whether Hg sources from geologic formations or past unknown mines are influencing creeks.
E1-14	Pine Tree Canyon	
E1-15	Inlet to Almaden-Calero Canal from Almaden Reservoir**	Measure total Hg and MeHg concentrations at inlet and outlet when being transferred to Calero Reservoir to see if Hg concentrations change due to sediment pickup or other processes during transit and to measure Hg concentrations reaching Calero.
E1-16	Outlet to Almaden-Calero Canal from Almaden Reservoir**	
E1-17	**Lexington Reservoir outlet** (gauged)*	Measure wet weather Hg concentrations to Los Gatos Creek and compare to dry weather concentrations. Compare Hg results for developed and undeveloped areas.
E1-18	Limekiln Canyon	Measure wet weather Hg concentrations in tributaries and compare to estimated load from atmospheric deposition. This watershed provides the best estimate of the effect of atmospheric deposition and natural geologic formations, and can be used to ground truth estimates using measured atmospheric Hg loading rates from other stations. These creeks have not been sampled.
E1-19	Soda Spring	
E1-20	Brigg Creek at CDF	
E1-20up	Brigg Creek at Bear Creek Road	
E1-21	Upper Los Gatos Creek	
E1-22	Lyndon Canyon	

*Sampled three times; ** Sampled two times.

"E1-20up". Measurements were made of suspended sediments, flow rates at ungauged locations, total and dissolved mercury, and methylmercury in each creek upstream of where it enters the reservoir. The reservoir outlets and canal samples were also analyzed for dissolved methylmercury.

Event 2 was conducted during a second storm on March 26, 2004 on three streams that drain mined areas (E1-3, E1-7, and E1-9), the four reservoir outlets, and the canal inlet and outlet to estimate variability. All water samples were analyzed for total and dissolved mercury and methylmercury. The reservoir outlets and canal samples were also analyzed for dissolved methylmercury.

Event 3 consisted of sampling the four reservoir outlets on a non-storm day (March 8, 2004). All water samples were analyzed for total and dissolved mercury and total and dissolved methylmercury. The canal inlet and outlet were not sampled a third time, as there was no flow at the outlet to Calero Reservoir on the days visited.

Use of Data in the TMDL: The results from this sampling element have been used to provide:

- Estimates of the relative magnitude of total and dissolved mercury and methylmercury concentrations in tributaries that enter the reservoirs during the wet season
- Wet season load estimates for each tributary sampled
- Comparison of the percentage of mercury load attributable to atmospheric deposition and the total load in mercury and non-mercury enriched areas.

The results of this sampling element will be used in the TMDL to develop a quantitative relationship between rainfall and mercury load to reservoirs, thus providing a basis to identify the importance and magnitude of wet weather sources relative to internal sources in the reservoirs. Load estimates are presented in Chapter 8 of this report.

3.2 SAMPLE RESULTS: TRIBUTARIES TO RESERVOIRS

The flows for the tributaries and outlets on the three sampling events are presented in Table 3-2. The greatest difference in flows from the tributaries was between those to the Almaden and Lexington Reservoirs. Each reservoir watershed had one dominant inflow. For Calero Reservoir, the dominant inflow was the Almaden-Calero Canal for these sampling events, although releases to the canal are variable.

The suspended solids and mercury results are presented in Table 3-3. The chemical data are summarized below:

Table 3-2.
Flows for Reservoir Tributaries and Outlets, Wet Season Sampling 2004

Station No.	Station Name	Date	Time	Gauged Flow, cfs	Est Flow, cfs
E1-1	**Almaden Reservoir Outlet**	3/2/2004	12:00	30.2	
E1-1	Almaden Reservoir Outlet	3/8/2004	14:00	21.4	
E1-1	Almaden Reservoir Outlet	4/14/2004	10:10	5.4	
E1-2	Herbert Creek	3/2/2004	15:10		43.4
E1-3	Jacques Gulch above Mine Hill Tributary	3/2/2004	15:00		0.75
E1-3A	Jacques Gulch above Mine Hill Tributary	3/26/2004	9:30		0.91
E1-4	Barret Canyon	3/2/2004	15:35		31.2
E1-5	Larrabee Gulch	3/2/2004	13:35		1.50
E1-6	W. Tributary from Mine Hill to Reservoir	3/2/2004	14:30		0.03
E1-7	Mine Hill Tributary to Jacques Gulch	3/2/2004	15:30		0.4
E1-7	Mine Hill Tributary to Jacques Gulch	3/26/2004	10:31		0.5
E1-8	**Guadalupe Reservoir Outlet**	3/2/2004	13:35	5.2	
E1-8	Guadalupe Reservoir Outlet	3/8/2004	14:50	5.2	
E1-8	Guadalupe Reservoir Outlet	4/14/2004	9:18	6.25	
E1-9	N. Los Capitancillos Creek	3/26/2004	9:00		1.58
E1-9A	N. Los Capitancillos Creek	3/3/2004	9:55		0.17
E1-10	Upper Guadalupe Creek	3/2/2004	14:15		3.76
E1-11	Rincon Creek	3/2/2004	13:55		4.94
E1-12	**Calero Reservoir Outlet**	3/2/2004	9:55	3	
E1-12	Calero Reservoir Outlet	3/8/2004	13:10	2.9	
E1-12	Calero Reservoir Outlet	4/14/2004	9:15	3	
E1-13	Cherry Canyon	3/2/2004	9:25		1.13
E1-14	Pine Tree Canyon	3/2/2004	10:30		1.89
E1-15	Inlet to Almaden-Calero Canal	3/2/2004	11:30	NA	
E1-15	Inlet to Almaden-Calero Canal	3/3/2004	11:03	NA	
E1-16	Outlet to Almaden-Calero Canal	3/2/2004	8:25	3.8	
E1-16	Outlet to Almaden-Calero Canal	3/3/2004	11:34	59.4	
E1-17	**Lexington Reservoir Outlet**	3/2/2004	9:10	6.1	
E1-17	Lexington Reservoir Outlet	3/8/2004	9:45	2.7	
E1-17	Lexington Reservoir Outlet	4/20/2004	7:30	31.8	
E1-18	Limekiln Canyon	3/2/2004	9:45		2.4

Table 3-2. (continued)
Flows for Reservoir Tributaries and Outlets, Wet Season Sampling 2004

Station No.	Station Name	Date	Time	Gauged Flow, cfs	Est Flow, cfs
E1-19	Soda Spring	3/2/2004	10:15		10.5
E1-20	Briggs Creek at CDF	3/2/2004	12:25		<0.1*
E1-20	Briggs Creek at Bear Creek Road	3/8/2004	8:30		1.88
E1-21	Upper Los Gatos Creek	3/2/2004	11:50		45.6
E1-22	Lyndon Canyon	3/2/2004	11:00		13.2

*Considered to be affected by backwater from reservoir, so sampled upstream.

Table 3-3.
Aqueous Mercury Speciation in Reservoir Tributaries and Outlets, Wet Season 2004

					Total Mercury				Methyl Mercury			
Location	Sample ID	Date Sampled	Time	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Almaden Reservoir Outlet	E1-1	3/2/2004	12:00	11.1	36.6	8.25	2,551	5.49	0.328	0.149	16.11	5.03
Almaden Reservoir Outlet	E1-1	3/8/2004	14:00	8.9	37.5	5.56	3,591	5.81	0.233	0.156	8.65	4.74
Almaden Reservoir Outlet	E1-1	4/14/04	10:10	15.9	38.79	3.59	2,214	5.79	0.29	0.114	11.07	4.99
Herbert Creek	E1-2	3/2/2004	15:10	3.7	3.47	0.98	682	5.84	0.051	NA	NA	NA
Jacques Gulch above MH	E1-3	3/2/2004	15:00	2	8.74	1.19	3,775	6.5	0.029	NA	NA	NA
Jacques Gulch above MH	E1-3A	3/26/2004	9:30	2	2.06	0.79	635	5.91	0.144	NA	NA	NA
Jacques Gulch above MH	E1-3B	3/26/2004	9:30	2	2.03	0.59	720	6.09	0.03	NA	NA	NA
Barret Canyon	E1-4	3/2/2004	15:35	3.3	4.68	0.91	1,160	6.11	0.042	NA	NA	NA
Larrabee Gulch	E1-5	3/2/2004	13:35	1.4	6.17	3.94	1,593	5.61	0.061	NA	NA	NA
W Trib from MH to Alm R	E1-6	3/2/2004	14:30	2.4	82.2	11.5	29,463	6.41	0.189	NA	NA	NA
MH Trib to Jacques Gulch	E1-7	3/2/2004	15:30	0.4	45.6	24.2	61,257	6.4	0.086	NA	NA	NA
MH Trib to Jacques Gulch	E1-7	3/26/2004	10:31	0.4	42.2	23.5	46,725	6.3	0.055	NA	NA	NA
Guadalupe Reservoir Outlet	E1-8	3/2/2004	13:35	47.5	77.4	6.25	1,498	5.38	0.319	0.152	3.52	4.36
Guadalupe Reservoir Outlet	E1-8	3/8/2004	14:50	32.3	38.4	5.41	1,022	5.28	0.287	0.149	4.28	4.46
Guadalupe Reservoir Outlet	E1-8	4/14/04	9:18	12.3	23.56	4.82	1,524	5.5	0.704	0.179	42.68	5.38
N. Los Capitancillos Creek	E1-9	3/26/2004	9:00	3.2	13.4	6.57	2,128	5.51	0.047	NA	NA	NA
N. Los Capitancillos Creek	E1-9A	3/3/2004	9:55	18.9	35.1	8.3	1,421	5.23	0.185	NA	NA	NA
N. Los Capitancillos Creek	E1-9B	3/3/2004	9:55	18.4	18.2	6.68	630	4.97	0.199	NA	NA	NA
Upper Guadalupe Creek	E1-10	3/2/2004	14:15	1.3	3.33	1.31	1,616	6.09	0.035	NA	NA	NA
Rincon Creek	E1-11	3/2/2004	13:55	3	2.52	1.1	473	5.63	0.05	NA	NA	NA
Calero Reservoir Outlet	E1-12	3/2/2004	9:55	17.4	19.8	5.04	847	5.23	0.103	0.085	1.03	4.08
Calero Reservoir Outlet	E1-12	3/8/2004	13:10	11.8	12.92	4.48	715	5.2	0.136	0.079	4.83	4.79
Calero Reservoir Outlet	E1-12	4/14/04	9:15	6.3	7.03	3.35	584	5.24	0.163	0.102	9.68	4.98

Table 3-3. (continued)
Aqueous Mercury Speciation in Reservoir Tributaries and Outlets, Wet Season 2004

					Total Mercury				Methyl Mercury			
Location	Sample ID	Date Sampled	Time	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Cherry Canyon	E1-13	3/2/2004	9:25	1.5	3.96	2.29	1,152	5.7	0.034	NA	NA	NA
Pine Tree Canyon	E1-14	3/2/2004	10:30	4.8	6.98	3.9	648	5.22	0.151	NA	NA	NA
Inlet ot Almaden-Calero Canal	E1-15	3/2/2004	11:30	12.2	32.85	8.61	1,995	5.36	0.251	0.11	11.6	5.02
Inlet ot Almaden-Calero Canal	E1-15	3/3/2004	11:03	10	28.83	7.71	2,123	5.44	0.257	0.125	13.27	5.03
Outlet ot Almaden-Calero Canal	E1-16	3/2/2004	8:25	7.7	24.67	8.16	2,158	5.42	0.216	0.153	8.24	4.73
Outlet ot Almaden-Calero Canal	E1-16	3/3/2004	11:34	17.9	90.54	6.49	4,709	5.86	0.289	0.096	10.81	5.05
Lexington Reservoir Outlet	E1-17	3/2/2004	9:10	97.6	16.44	2.23	146	4.82	0.072	0.023	0.5	4.34
Lexington Reservoir Outlet	E1-17	3/8/2004	9:45	52.8	9.26	1.95	139	4.85	0.057	0.01	0.89	4.95
Lexington Reservoir Outlet	E1-17	4/20/04	7:30	23	5.86	1.45	192	5.12	0.063	0.022	1.78	4.91
Limekiln Canyon	E1-18	3/2/2004	9:45	3.5	2.79	1.63	334	5.31	0.032	NA	NA	NA
Soda Spring	E1-19	3/2/2004	10:15	1.2	1.96	1.27	575	5.66	0.017	NA	NA	NA
Briggs Creek at CDF	E1-20	3/2/2004	12:25	31.8	6.98	1.82	162	4.95	0.085	NA	NA	NA
Briggs Creek at Bear Creek Road	E1-20up	3/8/2004	8:30	2.6	1.92	1.63	114	4.84	0.014	NA	NA	NA
Upper Los Gatos Creek	E1-21	3/2/2004	11:50	15.2	4.1	0.95	207	5.34	0.027	NA	NA	NA
Lyndon Canyon	E1-22	3/2/2004	11:00	54.1	13.54	1.24	227	5.26	0.141	NA	NA	NA

analyzed by Frontier Geosciences Aquatic Geochemistry Group

total Hg byBrCl digestion + $SnCl_2$ reduction, dual amalgamation CVAFS; CH_3Hg by distillation + aqueous ethylation + GC-CVAFS

Filtered Hg used 0.4 m filter.

NA indicates that parameter was not analyzed.

Field replicate samples are indicated by A or B after the sample ID.

- **Suspended solids.** The suspended solids concentrations ranged from 0.4 mg/L in the Mine Hill tributary to Jacques Gulch, a tributary to Almaden Reservoir, to 54 mg/L in Lyndon Canyon, a tributary to Lexington Reservoir. The suspended solids in the reservoir outlets ranged from 6.3 to 97.6 mg/L. The suspended solids in the canal varied from 7.7 to 17.9 mg/L.

- **Total Mercury.** The total mercury concentrations in the tributary samples ranged from 1.9 in Briggs Creek at Bear Creek Road, a tributary to Lexington Reservoir, to 82 ng/L, in the West tributary from Mine Hill to Almaden Reservoir. The total mercury concentrations in the reservoir outlet samples ranged from 5.9 to 77.4 ng/L. The total mercury in the canal samples ranged from 24.7 to 90.5 ng/L. As seen in Figure 3-2, the tributaries to Guadalupe and Almaden Reservoirs had higher total mercury concentrations than the other tributaries. The percent dissolved mercury was variable, but lowest in the Lexington Reservoir tributaries.

- **Methylmercury**. The methylmercury in the tributaries ranged from 0.014 ng/L in Briggs Creek at Bear Creek Road, a tributary to Lexington Reservoir, to 0.2 ng/L in N. Los Capitancillos Creek, a tributary to Guadalupe Reservoir. The outlets of the reservoirs had a larger range of methylmercury concentrations (0.06 to 0.70 ng/L). Methylmercury concentrations in the canal ranged from 0.22 to 0.29 ng/L. As observed in Figure 3-3, the reservoir outlets from Almaden and Guadalupe Reservoirs had higher methylmercury than most of the tributaries. The dissolved fraction was significant, even when the methylmercury concentrations were low.

- **Mercury in Particulate Fraction**. The mercury content on the suspended particulates was calculated from the total and dissolved mercury concentrations, and expressed on a mass basis, i.e., ng of mercury per gram of suspended matter. The mercury content in the suspended fraction can indicate the mercury concentration of future sediment if it settles at a downstream location. The Guadalupe Workgroup asked whether the mercury concentration of the particulates was less than 200 ng/g, the proposed median suspended sediment target for the San Francisco Bay TMDL. If so, one of the proposed targets for the San Francisco Bay TMDL would be met. The samples from the tributaries to Lexington had low mercury concentrations in the particulate fraction, 114 to 575 ng/g. In comparison, the samples from mine-influenced tributaries had mercury concentrations in the particulate fractions ranging from 630 ng/g to 61,257 ng/g. Only one tributary to Lexington and the Lexington outlet had mercury concentrations in the particulate fraction less than 200 ng/g. Most of the particulate-fraction concentrations measured in tributaries from the upper watershed and the reservoir outlets are higher than the desired criterion.

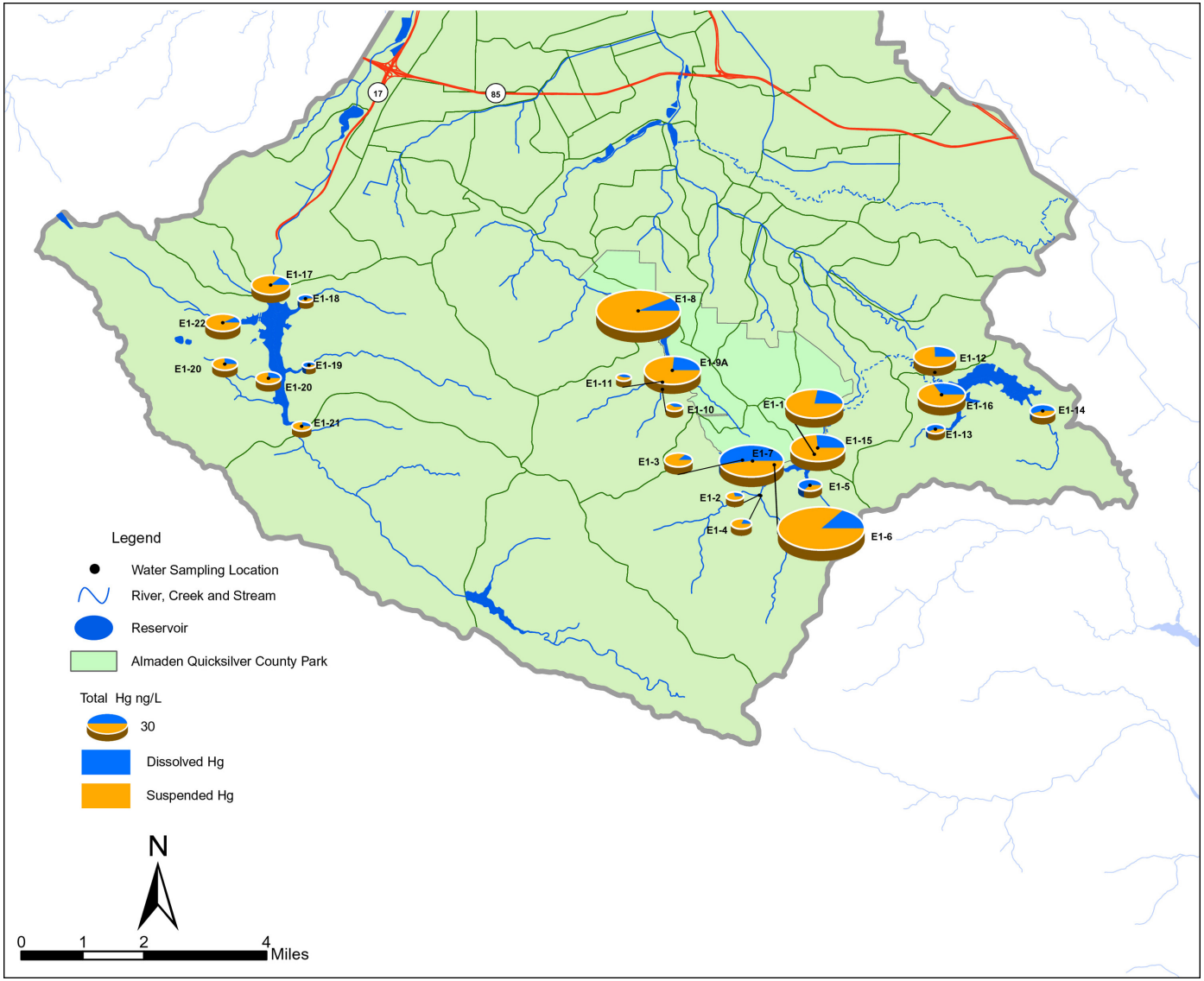


Figure 3-2. Total and dissolved mercury in reservoir watershed water samples.

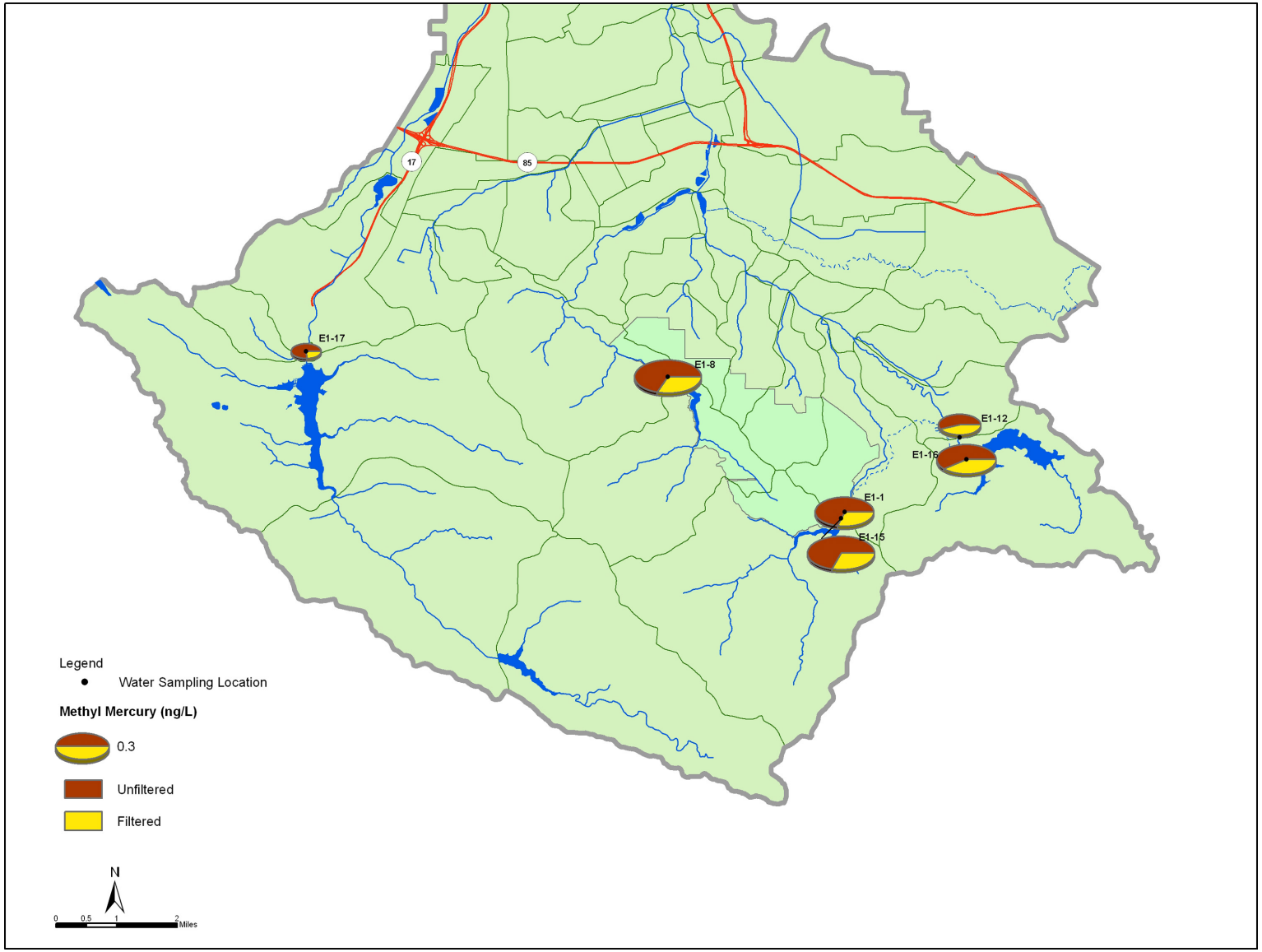


Figure 3-3. Methylmercury in reservoir outlet and canal water samples.

Partition coefficients were computed for both total and methyl mercury, and are included in Table 3-3. Partition coefficients indicate the tendency of the particulate-associated mercury to be sorbed to particles. The partition coefficients are expressed as log Kd, representing a ratio of mercury in the solid to liquid phases. A higher Kd value indicates that the mercury is more likely to remain in the solid phase, rather than be dissolved into the water column. The coefficients were computed for all the water samples. The log Kd values for total mercury ranged from 4.82 to 6.41. The higher log Kd values were associated with the higher total mercury concentrations, and thus are less available for dissolution. The Kd values for methylmercury had less variability, ranging from 4.08 to 5.38. The lower values indicate that methylmercury sorbs less strongly than inorganic mercury, represented by the total mercury since most of it is inorganic.

Field-parameter measurements are presented in Table 3-4. The pH of the reservoir outlets and tributaries were alkaline, ranging from 7.39 to 8.47 with similar ranges for each reservoir watershed. At the time of sampling, dissolved oxygen was high in all locations. Turbidity was higher in the reservoir outlets than the tributaries, particularly for Lexington, consistent with its higher suspended solids concentrations.

3.3 COMPARISON OF RESULTS FOR TRIBUTARIES

The concentrations of the three measured mercury species in the tributaries are compared in Figure 3-4. The highest total and dissolved mercury concentrations measured were found in the three tributaries draining the mining area. The highest methylmercury concentration was in the outlet of the Almaden-Calero Canal.

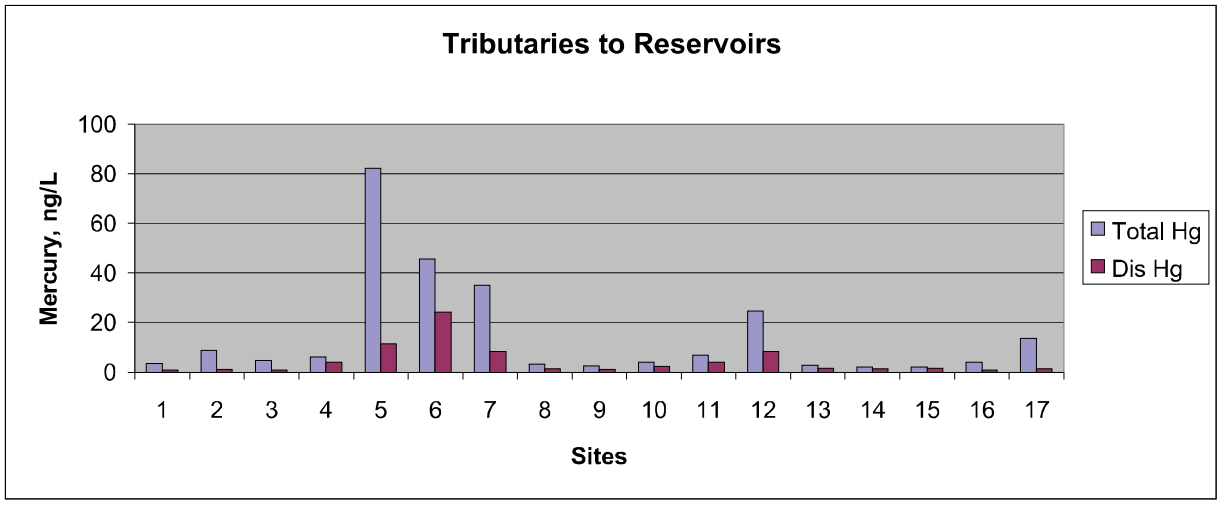
The mercury concentrations in the tributaries to Lexington Reservoir were comparatively low, except for one, Lyndon Canyon. This tributary had suspended solids of 54.1 mg/L, total mercury of 13.54 ng/L, and methylmercury of 0.14 ng/L. The higher mercury concentration is partly due to the higher suspended solids. One of the original questions regarding Lexington Reservoir was whether higher mercury would be found due to unknown mines, small deposits of mercury-bearing formations such as silica carbonate, or atmospheric fallout from retorts and furnaces used in the mining area in the Guadalupe and Almaden watersheds. Each of these possibilities is explored. First, there are no known silica carbonate deposits or past mining in the Lyndon Canyon subwatershed, and there is minimal development. Most of the land is used for a county park. Second, fallout from the retorts and furnaces is not thought to be the cause of the elevated mercury, since there is a high-elevation ridge separating the Guadalupe and Lexington subwatersheds, which would receive more local deposition. If that had occurred, the two subwatersheds draining the downstream side of that ridge, Limekiln Canyon and Soda Spring, would have had higher mercury. In fact, Limekiln Canyon and Soda Spring Creek had similar low total mercury concentrations (about 1.9 ng/L). Another possible explanation for the higher concentrations is that the atmospheric deposition is higher on the northwest side of the reservoir. This explanation is unlikely since the highest point in the subwatershed is in the Upper Los Gatos Creek area, which had a lower total mercury concentration.

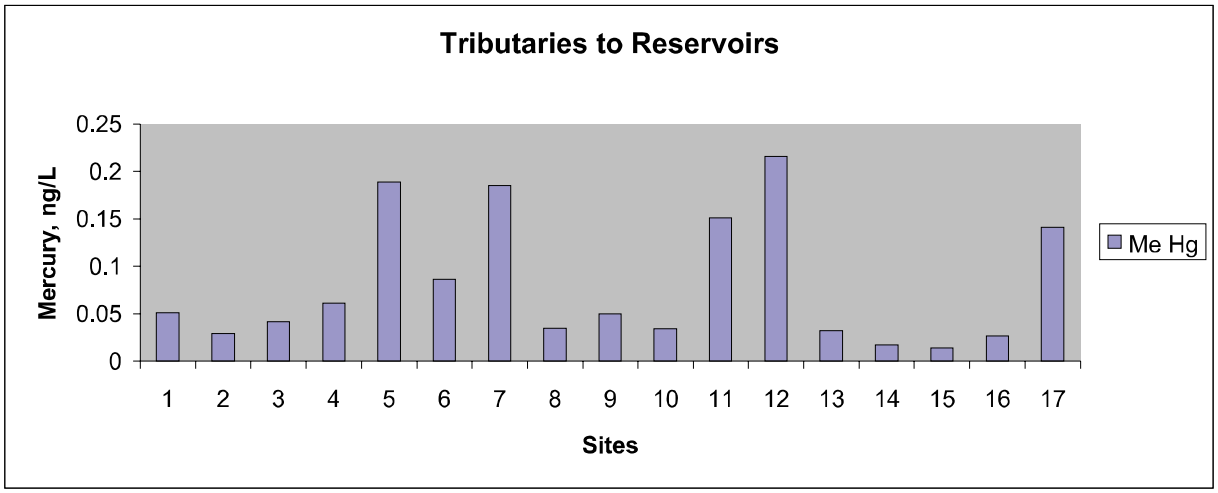
Table 3-4.
Field Parameters for Reservoir Tributaries and Outlets, Wet Season Sampling 2004

Station No.	Station Name	Date	Time	pH	Temp. (°C)	Cond. (uS/cm)	D.O. (mg/L)	% Sat.	Turbidity (NTU)
E1-1	**Almaden Reservoir Outlet**	3/2/2004	12:00	7.64	10.7	194.5	9.71	87.0	25.1
E1-1	Almaden Reservoir Outlet	3/8/2004	14:00	7.94	11.0	224.3	9.31	84.2	23.0
E1-1	Almaden Reservoir Outlet	4/14/2004	10:10	7.73	12.1	250.5	4.75	44.0	24.4
E1-2	Herbert Creek	3/2/2004	15:10	7.87	10.8	218.1	10.51	95.3	3.8
E1-3	Jacques Gulch above Mine Hill Tributary	3/2/2004	15:00	8.04	10.85	262	8.31	75.2	3.5
E1-3A	Jacques Gulch above Mine Hill Tributary	3/26/2004	9:30	8.31	11.31	322	10.97	100.3	1
E1-4	Barret Canyon	3/2/2004	15:35	7.87	10.9	241.9	10.73	97.1	3.38
E1-5	Larrabee Gulch	3/2/2004	13:35	7.90	10.5	309.2	11.06	99.3	6.30
E1-6	W. Tributary from Mine Hill to Reservoir	3/2/2004	14:30	7.61	12.9	405.8	9.04	85.7	10.6
E1-7	Mine Hill Tributary to Jacques Gulch	3/2/2004	15:30	8.2	12.42	580	7.85	73.6	3.7
E1-7	Mine Hill Tributary to Jacques Gulch	3/26/2004	10:31	8.26	13.59	784	9.46	91.3	0.0
E1-8	**Guadalupe Reservoir Outlet**	3/2/2004	13:35	7.7	10.61	219	8.07	72.7	65
E1-8	Guadalupe Reservoir Outlet	3/8/2004	14:50	7.70	10.3	235.7	8.32	74.2	56.5
E1-8	Guadalupe Reservoir Outlet	4/14/2004	9:18	7.39	9.91	223	8.70	77.0	14.4
E1-9	N. Los Capitancillos Creek	3/26/2004	9:00	8.47	10.33	497	11.93	106.7	0.4
E1-9A	N. Los Capitancillos Creek	3/3/2004	9:55	8.19	8.76	366	9.36	80.6	26.4
E1-10	Upper Guadalupe Creek	3/2/2004	14:15	8	10.37	177	8.7	77.8	1.6
E1-11	Rincon Creek	3/2/2004	13:55	8.1	10.53	182	8.69	78	5.4
E1-12	**Calero Reservoir Outlet**	3/2/2004	9:55	7.48	11.3	258.0	9.55	87.8	37.8
E1-12	Calero Reservoir Outlet	3/8/2004	13:10	7.97	11.7	256.7	10.20	93.9	24.5

Table 3-4. (continued)
Field Parameters for Reservoir Tributaries and Outlets, Wet Season Sampling 2004

Station No.	Station Name	Date	Time	pH	Temp. (°C)	Cond. (uS/cm)	D.O. (mg/L)	% Sat.	Turbidity (NTU)
E1-12	Calero Reservoir Outlet	4/14/2004	9:15	7.77	12.0	136.7	4.38	40.5	3.7
E1-13	Cherry Canyon	3/2/2004	9:25	7.55	9.8	236.5	10.11	89.2	6.2
E1-14	Pine Tree Canyon	3/2/2004	10:30	7.48	11.4	416.1	9.65	88.3	17.8
E1-15	Inlet to Almaden-Calero Canal	3/2/2004	11:30	7.65	10.7	193.0	10.52	94.7	24.5
E1-15	Inlet to Almaden-Calero Canal	3/3/2004	11:03	7.86	10.7	202	8.1	73	13.4
E1-16	Outlet to Almaden-Calero Canal	3/2/2004	8:25	7.65	9.4	207.5	12.15	106.5	23.5
E1-16	Outlet to Almaden-Calero Canal	3/3/2004	11:34	8.06	11.29	212	12.44	113.7	17.6
E1-17	**Lexington Reservoir Outlet**	3/2/2004	9:10	7.81	10.84	242	10.4	95	150
E1-17	Lexington Reservoir Outlet	3/8/2004	9:45	8.03	11.1	254.0	11.10	101.6	99.2
E1-17	Lexington Reservoir Outlet	4/20/2004	7:30	7.56	11.3	247.0	10.39	96.0	44.8
E1-18	Limekiln Canyon	3/2/2004	9:45	8.09	10.12	240	8.1	73	5
E1-19	Soda Spring	3/2/2004	10:15	8.06	9.46	183	8.5	77.2	3.6
E1-20	Briggs Creek at CDF	3/2/2004	12:25	7.82	9.73	267	8.67	76.4	138
E1-20	Briggs Creek at Bear Creek Road	3/8/2004	8:30	7.77	11.2	285.2	10.35	94.8	6.9
E1-21	Upper Los Gatos Creek	3/2/2004	11:50	7.89	11.19	294	8.51	77.6	16
E1-22	Lyndon Canyon	3/2/2004	11:00	8.04	9.98	234	8.93	79.2	36.5





Almaden Reservoir

1 E1-02 Herbert Creek
2 E1-03 Jacques Gulch abv MH
3 E1-04 Barret Canyon
4 E1-05 Larrabee Gulch
5 E1-06 W Trib from Mine Hill
6 E1-07 Mine Hill trib to J Gulch

Guadalupe Reservoir

7 E1-09-A N Los Cap Creek
8 E1-10 Upper Guadalupe Creek
9 E1-11 Rincon Creek

Calero Reservoir

10 E1-13 Cherry Canyon
11 E1-14 Pine Tree Canyon
12 E1-16 Outlet to A-C Canal

Lexington Reservoir

13 E1-18 Limekiln Canyon
14 E1-19 Soda Spring
15 E1-20 Briggs Creek atBear Cr
16 E1-21 Upper Los Gatos Creek
17 E1-22 Lyndon Canyon

Figure 3-4. Comparison of mercury species in tributaries to the reservoirs

A plausible reason for the higher mercury in Lyndon Canyon is that the underlying geologic formations have inherently higher mercury concentrations than the Great Valley sequence of sandstones and shales found in the creeks to the south of the

reservoir (e.g. Upper Los Gatos Creek). Both Lyndon and Limekiln Canyon are underlain by the Franciscan mélange, consisting of metasandstones with blueshist, amphiolite, and chert blocks, graywacke sandstone, and volcanic basalt and flows. There may be pockets of serpentinized ultramafic rocks. Limekiln Canyon had higher total mercury concentrations than Soda Spring and Briggs Creek, but was considerably less than Lyndon Canyon, even though it has a small silica carbonate deposit. Lyndon Canyon follows the San Andreas Fault zone, so it could be more susceptible to landslides. Based on the information available, the tributaries in the Lexington Reservoir do not appear to be affected by effects of mercury mining.

The total mercury in the non-mine-influenced tributaries of the other reservoirs were similar: 3.47 to 6.17 ng/L for Almaden, 3.96 to 6.98 ng/L for Calero, and 2.52 to 3.33 ng/L for Guadalupe Reservoirs. Two tributaries to Lexington had lower concentrations (1.92 to 1.96 ng/L), two were similar (2.79 to 4.1 ng/L), and one Lyndon Canyon was higher (13.54 ng/L). The variation among the watersheds is evident in the box plot for total mercury (Figure 3-5a) and for methylmercury (Figure 3-5b). Lexington Reservoir tributaries were the lowest in both plots. Calero Reservoir has two tributaries with low mercury, but the canal has similar concentrations to the mine-influenced tributaries, so it appears closer to Guadalupe and Almaden Reservoirs than Lexington.

As hypothesized, the mercury from background sources to the watershed is measurable. Most of the tributaries had higher total mercury concentrations than the median of the 106 sites in the national pilot study conducted by the USGS, 2.28 ng/L (Krabbenhoft et. al., 1999). The median methylmercury in the 106 sites was 0.06 ng/L, compared to 0.029 to 0.15 ng/L in the non-mined tributaries and 0.055 to 0.199 in the mining area tributaries. These data are consistent with the hypothesis that mercury in this area is elevated due to mining and the natural geologic formations. An alternative explanation is higher atmospheric deposition due to the high rainfall amounts in the upper watersheds of 48 in/year (Tetra Tech, 2003d).

3.4 ASSESSMENT OF DATA QUALITY AND CONSTRAINTS

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004a, 2003 e) were followed. The QA/QC results are discussed in Appendix B, since the results cover multiple elements. The water data are usable for data analyses based on the QA/QC criteria.

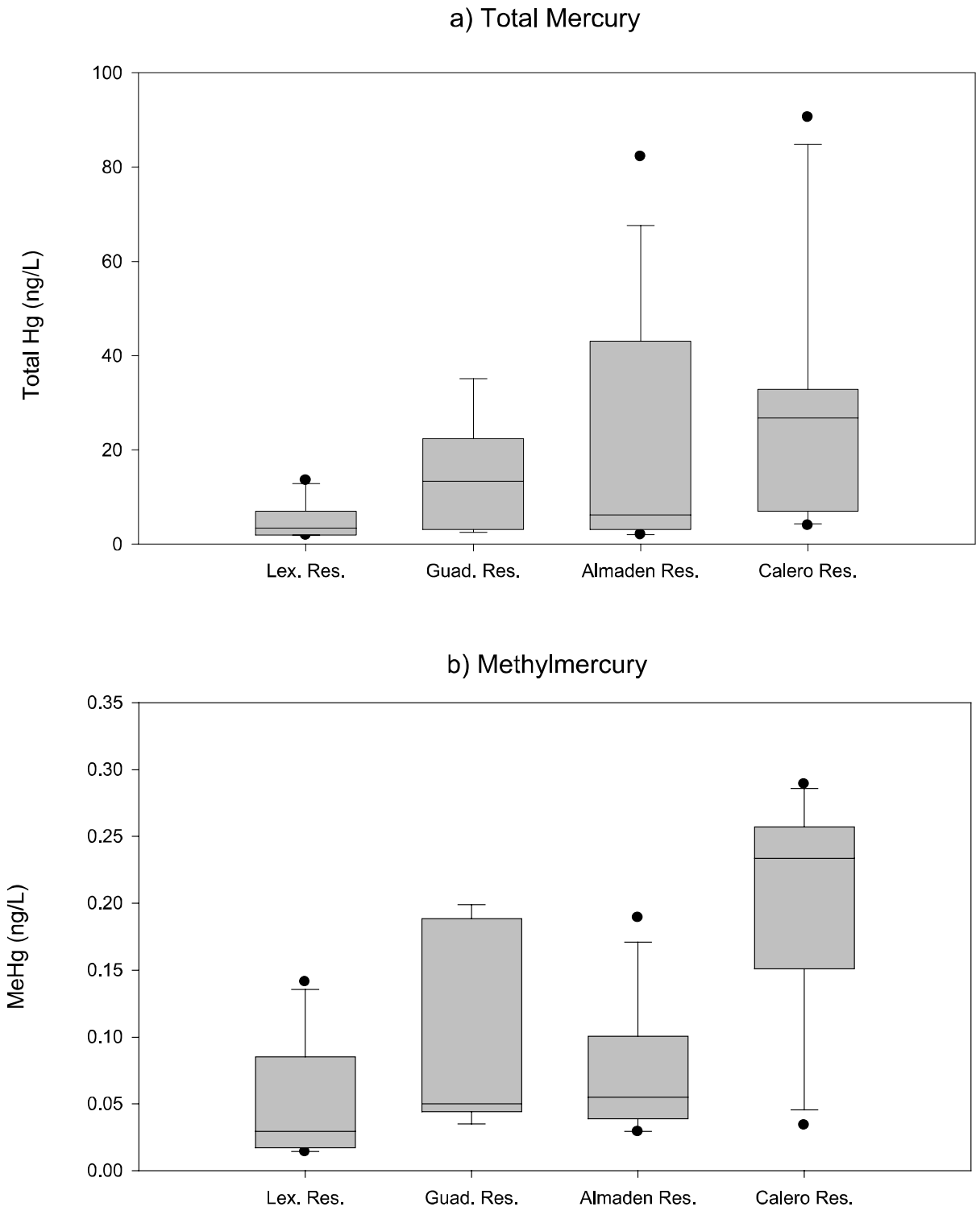


Figure 3-5. Box Plots for reservoir tributaries a) total mercury and b) methylmercury

The level of precipitation on the days when the tributaries to the reservoirs were sampled was low (less than 1 in) compared to 2.2 to 3 in for the storm event on February 26th; thus, higher suspended solids and possibly mercury may occur for larger storm events. The discharges from Guadalupe and Calero Reservoirs were low (less than 10 cfs) during the days sampled. However, suspended solids in the outlets were still higher than in the dry season when the suspended solids concentrations ranged from 1.2 to 2.1 mg/L in the July 2003 samples from the Synoptic Survey. The maximum flows of the discharges sampled from Almaden and Lexington Reservoirs were similar, 30.2 and 31.8 cfs, which is a moderate flow for these outlets.

The outlets were sampled on March 8, 2004 for the non-storm day at the same time as selected locations on the Guadalupe River and other major tributaries. The outlets were also sampled in late April at the same time as locations on Guadalupe and Alamitos Creeks as part of Element 2.

3.5 COMPARISON WITH PREVIOUS DATA

Water samples from two tributaries in the mining area have been analyzed for mercury and other parameters by the Santa Clara County Parks Department (SCPD). The four reservoir outlets were sampled for the Synoptic Survey in July 2003. The Almaden Reservoir outlet has been sampled seven times between June 2, 2003 and March 3, 2004 by Light, Air, and Space Construction (LAS) for SCVWD. The Lexington Reservoir outlet was sampled once by LAS in January 2004.

Mining Area Tributaries. Water samples have been collected by SCPD during rain events at Jacques Gulch Creek and N. Los Capitancillos Creek and other sites in the Almaden Quicksilver County Park (AQCP). Jacques Gulch has been sampled by SCPD seven times previously from January 2000 through April 2003 (Table 3-5). The 2004 results from SCPD were not available at the time of this report. Total mercury ranged from 6,667 ng/L in January 2000 during a large rain event (3.11 in with 2.52 on the previous day) to 0.9 and 1.7 ng/L on a different day with 0.59 in of rain in April 2003 (SCPD, 2003). The mean of the total mercury concentrations for the seven dates was 1,038 ng/L. The 2004 samples collected for the Data Collection Program had total mercury closer to the 2003 results, ranging from 2.03 to 8.74 ng/L for Jacques Gulch above the Mine Hill tributary. Rainfall for the two sampling periods were similar, both less than 1 in. The tributary from Mine Hill to Jacques Gulch had higher total mercury concentrations, ranging from 42.2 to 45.6 ng/L, showing that this tributary is the main source of the elevated mercury in Jacques Gulch. Total mercury in N. Los Capitancillos Creek in the 2004 samples (13.4 to 35.1 ng/L) was also similar to the 2003 samples (5.8 to 26 ng/L).

Table 3-5.
Total Mercury Concentrations in Mining Area (SCPD, 2003)

Date	Total Mercury, ng/L	Rain, in on Day Sampled	Rain on Previous Day
Jacques Gulch			
1/24/2000	6,667	3.11	2.52
4/14/2000	42	3.15	0.08
11/29/2000	NA	3.23	0
1/23/2001	4.3	4.33	0.04
12/28/2001	44.4	0.31	0
3/6/2002	501	0.59	1.06
2/12/2003	6/8/1.3	0.39	0.12
4/4/2003	1.7/0.9	0.59	0
N. Los Capitancillos Creek			
2/12/2003	26/17	0.39	0.12
4/4/2003	11/5.8	0.59	0

The four reservoir outlets were sampled for the Synoptic Survey in July 2003; the water quality from this survey are shown in Table 3-6. The dry season total mercury concentrations ranged from 3.8 ng/L to 18.9, compared to the wet season range from 5.9 to 77.4 ng/L. The reservoir outlets are compared in Figure 3-6a for suspended solids, Figure 3-6b for total mercury, Figure 3-6c for methyl mercury. These plots show that while suspended solids and total mercury were higher in the wet season, methyl mercury was higher in the dry season. The largest difference in total and methylmercury concentrations between seasons was seen in Guadalupe Reservoir; total mercury increased by a factor of two in the wet season, while methylmercury increased by a factor of about eight in the dry season. The dry season results for the outlets are clearly seen as distinct in plots of mercury and methylmercury versus suspended solids (Figure 3-7).

Additional sampling for mercury has been conducted at the Almaden Reservoir outlet for SCVWD by Light, Air, & Space Co (LAS). The results are shown in Table 3-7. One sample was collected from the outlet on March 3, 2004, the day after one of the Data Collection events. The LAS results for this outlet sample are: total mercury 24.6 to 25.8 ng/L, dissolved mercury 18.2 to 21.1 ng/L, and methylmercury 0.173 to 0.181 ng/L; suspended solids were <10 mg/L. The total and methylmercury in a sample collected for the Data Collection event were both slightly higher, but the dissolved mercury was lower: total mercury 37.5 ng/L, dissolved mercury 5.56 ng/L, and methylmercury 0.233 ng/L. The previous dry and wet weather samples from the outlet had higher total mercury in the wet season and higher methylmercury in the dry season, consistent with the Data Collection results. The new 2004 results were similar to the wet season results, although the total mercury and methylmercury

Table 3-6
Water Quality and Mercury in Creek Water Samples from Synoptic Survey

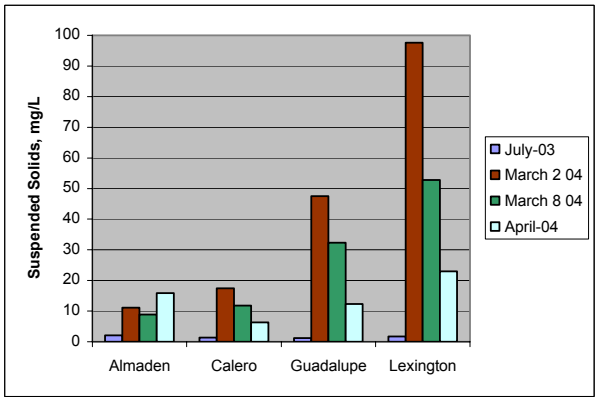
Site Number	Site Name	Sampling Date	Sampling Time	Temper-ature	Conduc-tivity	Total Suspended Solids	Dissolved Oxygen	pH	Alkalinity as $CaCO_3$	Chloride	Dissolved Organic Carbon
Creeks				°C	µS/cm	mg/L	mg/L		mg/L	mg/L	mg/L
Site 1	Alamitos Ck. at outlet to Almaden Reservoir	7/30/2003	7:00 AM	18.1	356	2.1	0.70	7.03	210	5.7	3.2
Site 2	Deep Gulch Creek	7/29/2003	8:35 AM	17.0	906	<0.9	8.66	8.63	540	12	<1
Site 3	Mine seep to Randoll Ck.	7/29/2003	10:45 AM	17.9	1232	2.3	7.05	8.43	500	16	2.7
Site 4	Alamitos Ck. behind museum	7/29/2003	9:30 AM	17.6	364	2	8.46	8.18	220	6.7	1.7
Site 5	Alamitos Ck. @ Harry Rd.	7/29/2003	7:25 AM	17.8	374	14	8.70	8.14	220	7.3	1.5
Site 5 rep	Alamitos Ck. @ Harry Rd.	7/29/2003	7:25 AM	17.8	374	5.5	8.7	8.14	220	7.3	<1
Site 6	Alamitos Ck. @ Mazzone Dr.	7/28/2003	11:30 AM	19.6	482	4.7	9.25	8.07	170	48	2.3
Site 7	Almaden Lake *	7/29/2003	1:00 PM	27.2/23.7	555/NS	53.8	>20.0/1.71	9.4/8.6	190	40	3
Site 8	Calero Ck. below Calero Reservoir outlet	7/30/2003	12:20 PM	15.3	328	1.3	1.10	7.47	130	30	4
Site 9	Calero Ck. @ Harry Rd.	7/29/2003	6:25 AM	17.7	362	7.5	8.02	8.20	140	32	3.1
Site 10	Guadalupe R. dwnstr of drop structure	7/28/2003	9:45 AM	24.0	536	12.5	7.40	8.53	190	42	2.8
Site 11	Guadalupe Ck. @ outlet to Guadalupe Reservoir	7/31/2003	2:35 PM	12.2	239	1.2	1.30	7.30	150	6.8	3.1
Site 12	Guadalupe Cr. @ gage on Hicks Rd.	7/28/2002	12:25 PM	14.9	264	<0.8	10.3	8.54	160	7.2	2.8
Site 13	Guadalupe Crk. upstream of Almaden Expwy.	7/28/2003	10:30 AM	17.5	322	1.3	10.7	8.50	170	12	1.8
Site 15	Canoas Creek before confluence	7/28/2003	8:15 AM	18.8	881	<0.9	5.33	8.13	360	70	3.2
Site 16	Los Gatos Ck. below outlet to Lexington Res.	7/31/2003	9:30 AM	14.7	293	1.7	9.48	7.36	130	8.5	3.6
Site 17	Los Gatos Creek before confluence	7/28/2003	6:15 AM	20.04	591	1.6	7.57	7.86	190	34	1.9

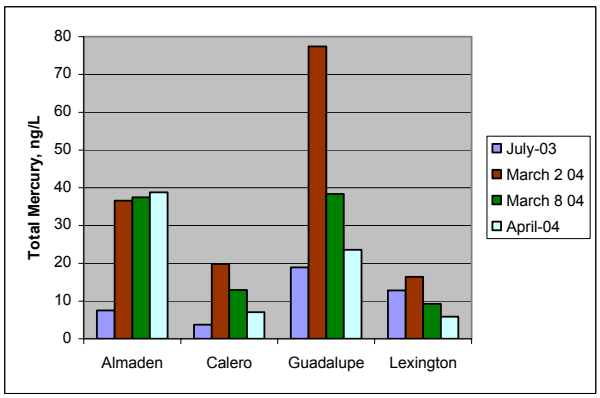
* Field measurements made at surface/depth of 10 ft

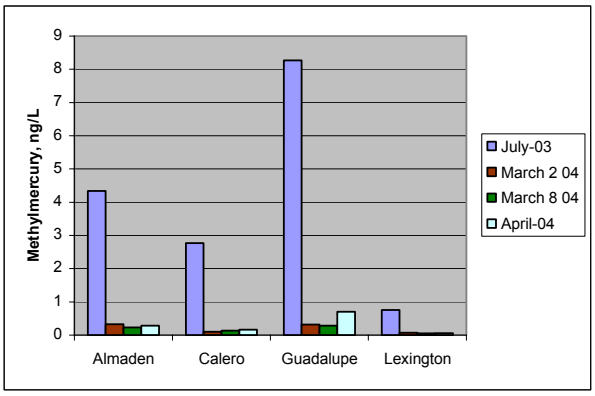
NS indicates not sampled

Table 3-6 (continued)
Water Quality and Mercury in Creek Water Samples from Synoptic Survey

Site Number	Site Name	Dissolved Iron	Total Iron	Total P	Sulfate	Sulfide	Total Hg	Dissolved Hg	Methyl Hg	Dissolved Methyl Hg	Particulate Hg	Particulate MeHg
Creeks		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**ng/L**	**ng/L**	**ng/L**	**ng/L**	**ng/g**	**ng/g**
Site 1	Alamitos Ck. at outlet to Almaden Reservoir	0.087	0.11	0.18	17	0.1	7.49	4.62	4.34	3.78	1,367	26.4
Site 2	Deep Gulch Creek	<0.025	0.11	0.32	180	<0.01	108.6	7.28	0.201	0.101	112,578	11.1
Site 3	Mine seep to Randoll Ck.	<0.025	<0.02 5	0.33	420	0.3	191.1	32.91	0.131	0.169	68,778	nc
Site 4	Alamitos Ck. behind museum	<0.025	0.1	0.27	20	<0.01	168.0	30.14	1.40	1.12	68,930	14.2
Site 5	Alamitos Ck. @ Harry Rd.	<0.025	0.63	0.23	19	<0.01	435.9	24.81	0.964	0.411	29,364	4.0
Site 5 rep	Alamitos Ck. @ Harry Rd.	<0.025	0.72	0.37	19	<0.01	570.4	34.39	0.807	0.384	97,456	7.7
Site 6	Alamitos Ck. @ Mazzone Dr.	<0.025	0.082	0.21	48	<0.01	25.88	6.65	0.306	0.181	4,091	2.7
Site 7	Almaden Lake *	<0.025	0.03	0.68	48	<0.01	25.36	4.40	17.85	1.72	390	30.0
Site 8	Calero Ck. below Calero Reservoir outlet	0.089	0.12	0.3	27	0.04	3.75	2.71	2.77	1.33	800	110.8
Site 9	Calero Ck. @ Harry Rd.	<0.025	0.99	0.42	27	<0.01	17.63	1.38	0.362	0.134	2,167	3.0
Site 10	Guadalupe R. dwnstr of drop structure	<0.025	0.43	0.19	48	<0.01	105.0	8.00	0.323	0.113	7,760	1.7
Site 11	Guadalupe Ck. @ outlet to Guadalupe Reservoir	0.1	0.19	0.11	15	0.02	18.89	8.63	8.27	6.073	8,550	182.8
Site 12	Guadalupe Cr. @ gage on Hicks Rd.	<0.025	0.14	0.2	18	<0.01	33.15	11.64	5.21	1.43	26,888	472.5
Site 13	Guadalupe Crk. upstream of Almaden Expwy.	<0.025	0.08	0.17	23	<0.01	38.90	6.33	0.990	0.608	25,054	29.4
Site 15	Canoas Creek before confluence	<0.025	0.025	0.38	99	<0.01	3.77	2.48	1.35	1.10	1,433	27.7
Site 16	Los Gatos Ck. below outlet to Lexington Res.	0.14	0.24	0.12	49	0.01	12.80	2.06	0.756	0.745	6,318	0.6
Site 17	Los Gatos Creek before confluence	<0.025	0.1	0.22	85	<0.01	3.17	1.00	0.037	0.002	1,356	2.2



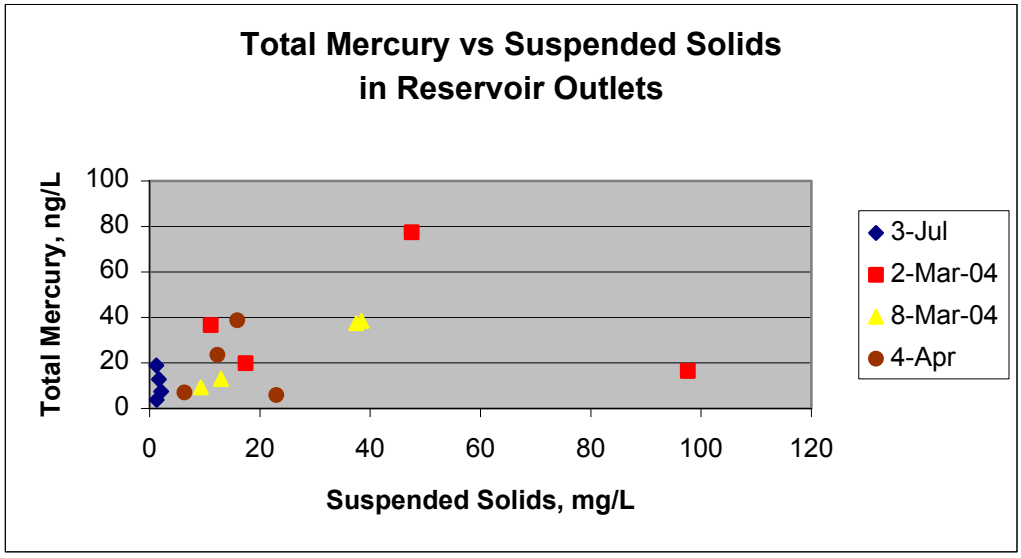




Outlet flows when sampled

Reservoir	July 2003	March 2,2004	March 8, 2004	April 2004
Almaden	5.93 cfs	30.2 cfs	21.4 cfs	5.4 cfs
Calero	3.7 cfs	3.0 cfs	2.9 cfs	3.0 cfs
Guadalupe	5.9 cfs	5.2 cfs	5.2 cfs	6.2 cfs
Lexington	23.4 cfs	6.1 cfs	2.7 cfs	31.8 cfs

Figure 3-6. Reservoir outlet samples: a) suspended solids, b) total mercury, c) methylmercury



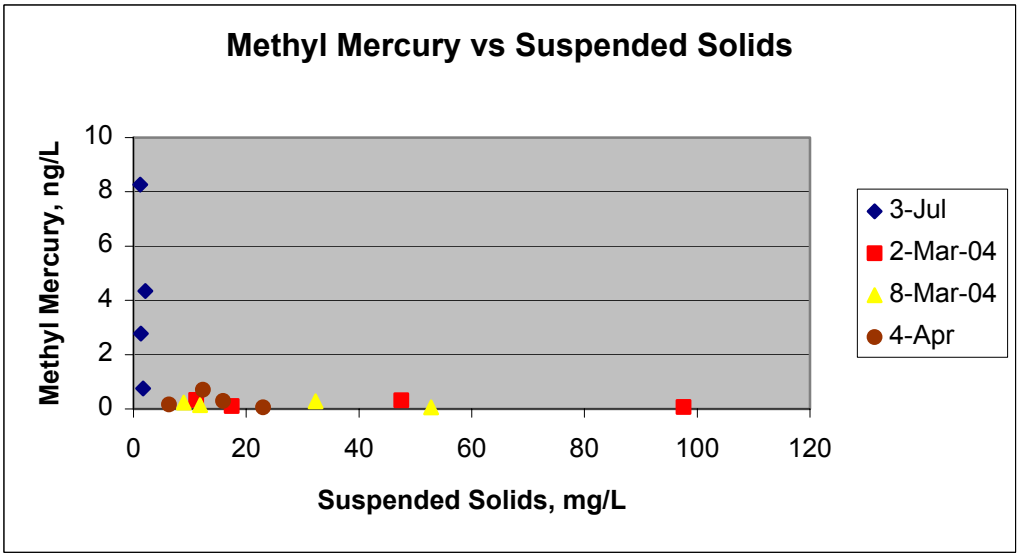


Figure 3-7. Total mercury and methylmercury versus suspended solids in reservoir outlet samples

concentrations were somewhat less. Similar to the March 3 results, the new 2004 results for dissolved mercury were much lower.

One sample was collected by LAS at the outlet to Lexington Reservoir on January 12, 2004. The results were: total mercury of 11.6 to 12.1 ng/L, dissolved mercury of 8.08 to 10.7 ng/L, and methylmercury of 0.125 to 0.142 ng/L. The results were within the range of the new 2004 samples for total mercury (5.86 to 16.44 ng/L). The other species were less (dissolved mercury of 1.45 to 2.23 ng/L and methylmercury of 0.057 to 0.072 ng/L).

Table 3-7.
Sampling Results for Almaden and Lexington Reservoir Outlets from LAS

Almaden Reservoir Outlet			Samples	Temp	pH	DO in Outlet	DO in Res	Conductivity	Turbidity	TSS	Total Hg	Diss Hg	MeHg	DOC	Sulfate	Sulfide	Chloride	Total Fe	Diss Fe
	Res Level	Outlet Flow	2 repls	deg C		mg/L	mg/L	mmhos/cm3	Ntu	mg/L	ng/L	ng/L	ng/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
6/2/2003			A	14.3	7.8	10.78	7.9	39	2	<10	14	14	<0.07	1.3	18	<1	12	<0.1	<0.1
9:49 AM	608.06	3.8	B				35 ft				31.4	29	<0.07	1.7	18	<1	11	<0.1	<0.1
7/17/2003			A	22.1	7.5	10.76	0.68	0.516	1	13	8.67	6.27	2.31	1.4	NA	NA	NA	NA	NA
11:45 AM	605.46	3.95	B				33 ft			<10	28.6	6.71	1.88	1.4	NA	NA	NA	NA	NA
8/18/2003			A	21.2	7.64	9.68		0.46	1	<10	10.2	9.36	10.5	2.2	13	NA	6.5	0.19	0.17
5:20 PM	602.25	4.62	B								10.7	9.53	9.72	2.4	13	NA	6.2	0.19	0.17
10/1/2003			A	21.9	7.97	NA	6.98	0.45	19	<10	16.7	14	2.27	1.9	17	NA	<10	0.34	0.11
2:06 PM	595.99	5.6	B				31 ft				14.8	14.4	2.08	2.8	20	NA	<10	0.16	0.36
10/31/2003			A	18.4	7.07	6.87L	4.93	0.405	23	14	31.1	34.1	0.604	2.4	15	NA	8.1	NA	NA
1:02 PM	590.08	4.8	B				25 ft			10	32.3	31.3	0.491	2.3	15	NA	9.6	NA	NA
12/8/2003			A	12.8	NA	NA	6.04	0.515	33	25	45.9	42.1	0.459	1.9	14	NA	12	NA	NA
2:56 PM	583.62	2.9	B				12 ft			31	44.8	48.5	0.401	1.9	22	NA	14	NA	NA
1/8/2004			A	10.9	7.29	8.46 L	6.42	0.28	52	12	55.2	39.6	0.437	3.1	15	NA	<10	NA	NA
9:49 AM	583.41	4.45	B				40 ft			11	51.6	35.6	0.389	3	16	NA	<10	NA	NA
3/3/2004	NA	NA	A	13.2	8.5	13.49	7.68	0.321	42	ND	24.6	21.1	0.181	1.6	12	NA	11	NA	NA
4:45 PM			B				39 ft				25.8	18.2	0.173	3.7	14	NA	ND	NA	NA
Lexington Reservoir Outlet (Lenihan Dam)																			
1/12/2004			A	10.7	8.15	13.98 (energy d)	6.43	0.367	121	20	11.6	10.7	0.125	3.8	58	NA	14	NA	NA
1:10 PM	607.06	7.1	B				64 ft			18	12.1	8.08	0.142	3.9	56	NA	11	NA	NA

Data collected by Light, Air, & Space Co. for SCVWD in 2003 and 2004.

Spillway elevations are: 608.7 ft at Almaden Reservoir and 619.78 ft at Lexington Reservoir.

4.0 ELEMENT 2–EROSION AND LOADS TO STREAMS DRAINING THE HISTORIC MINING AREAS

4.1 PURPOSE AND SAMPLING DESIGN: ELEMENT 2

Runoff from former mining areas and in-stream processes are contributing mercury to Guadalupe, Alamitos and Calero Creeks, three of the major tributaries to the Guadalupe River. Sampling was conducted to answer the following question posed by the Guadalupe Mercury Work Group:

What is the contribution to loading from in-stream processes including erosion and bed material suspension?

Sampling Element 2 was designed to address two hypotheses:

1. *Mobilization of sediments during storm events increases total, dissolved, and methyl mercury concentrations in waterways.*

2. *Mercury concentrations associated with mobilization of sediments decreases with distance from the mined areas.*

Sampling Design: Three sampling events were conducted between March 8 and April 23, 2004. Event 1 consisted of sampling 18 sites on Alamitos, Guadalupe, and Calero Creeks and their tributaries. The locations were selected to distinguish the mercury load coming from tributaries from erosion and sediment resuspension. On the dates visited, there was no flow from Randol Creek to Alamitos Creek due to the presence of a series of drop structures that impound and retain water. Therefore, the Randol Creek site was moved further upstream to a tributary that is spring-fed and may be influenced by discharges from the mining area. Descriptions of the sampling locations and the rationale are provided in Table 4-1; the sampling locations are shown on a map on Figure 4-1. Measurements were made of suspended sediments,

Table 4-1.
Description of Sampling Stations and Rationale for Element 2: Erosion in Alamitos and Guadalupe Creeks

Sampling Site ID	Sampling Station Description	Rationale
E2-1	Guadalupe Creek upstream of Cherry Springs Creek	Measure Hg concentration above section of creek where potential influence of Guadalupe Mine could occur.
E2-2	Cherry Springs Creek	Measure Hg concentrations in creek that receives flow from mine waste.
E2-3	Pheasant Creek	Measure Hg concentrations from creeks that drain background area with limited development. Not previously sampled.
E2-4	Shannon Creek	
E2-5	Guadalupe Creek at old gauge*	Compare wet weather Hg concentrations to above tributaries and to previous samples
E2-6	Guadalupe Creek below Masson Dam*	Measure Hg concentrations below impoundment. Compare to upstream sample.
E2-7	Guadalupe Creek above Almaden Expressway***	Measure Hg concentrations at outlet of Guadalupe Creek to lower watershed. Compare to previous Hg and MeHg data.
E2-8	Deep Gulch at previously-used site	Measure Hg concentrations and compare to upstream Alamitos Creek samples. Compare to previous dry and wet Hg data.
E2-9	Alamitos Creek at Almaden Road bridge near AQC Park	Measure Hg concentrations in Alamitos Creek along different reaches to compare internal and external sources.
E2-10	Alamitos Creek at Harry Road*	
E2-11	Alamitos Creek at Greystone Lane*	
E2-12	Alamitos Creek above Almaden Lake**	Measure Hg concentration at inlet to Almaden Lake.
E2-13	Almaden Lake outlet*	Measure Hg concentration at outlet of Almaden Lake and compare to Alamitos and Guadalupe Creeks.
E2-14	Golf Creek upstream of Alamitos Creek	Measure Hg concentrations in Golf Creek. Creek receives flow from McAbee Creek draining the Senador Mining area, which has been sampled previously.
E2-15	Greystone Creek upstream of Alamitos Creek	Measure Hg concentrations in Greystone Creek from developed area not affected by mining. Compare to Randol and Golf Creeks that have mining influences.

*sampled twice; **sampled three times

Table 4-1. (continued)
Description of Sampling Stations and Rationale for Element 2: Erosion in Alamitos and Guadalupe Creeks

Sampling Site ID	Sampling Station Description	Rationale
E2-16	Randol Creek upstream of Alamitos Creek	Measure Hg concentrations in Randol Creek. Creek receives flow from mine seeps and small tributaries draining the eastern part of Almaden Quicksilver County Park. Mine seep was sampled previously, but flow does not reach mouth of Alamitos Creek in summer.
E2-17	Santa Teresa Creek upstream of Calero Creek	Measure Hg concentrations in Santa Teresa Creek and compare to outlet of Calero Reservoir and mouth of Calero Creek. See if any detectable influence from past Hg mining in watershed on Santa Teresa Creek. Santa Teresa Creek not previously sampled.
E2-18	Calero Creek at Harry Road	Measure Hg concentrations in Calero Creek and compare to outlet from Calero Reservoir to determine if internal sources are detectable

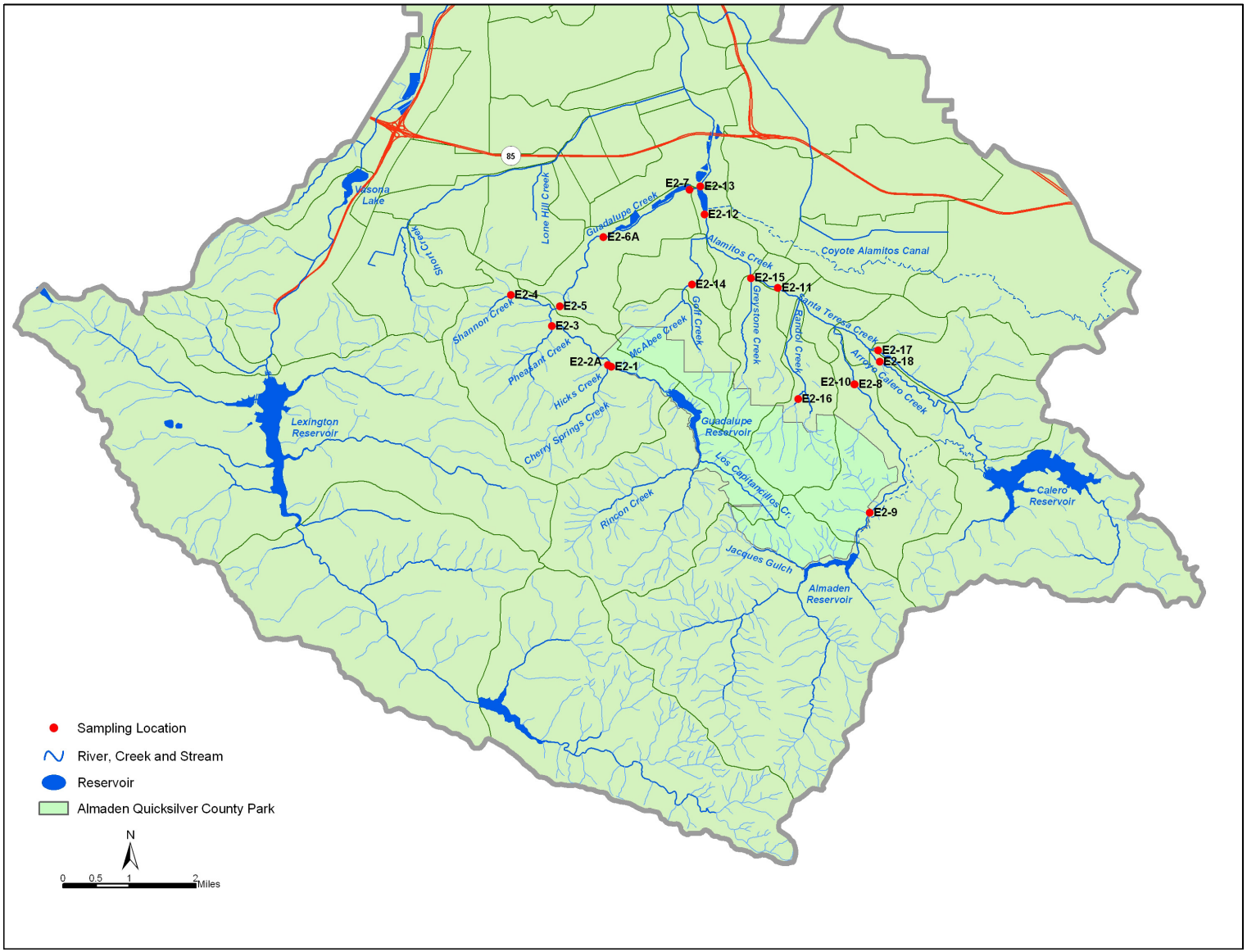


Figure 4-1. Sampling Locations for Element 2: Erosion and Tributary loads in stream drainage historic mining areas

flow rates at ungauged locations, total and dissolved mercury, and methylmercury at each location. Dissolved methylmercury was measured at five of the locations (E2-5, E2-7, E2-9, E2-12, and E2-13), two on Guadalupe Creek and three on Alamitos Creek. The Event 1 locations were not sampled on the same day due to limited rainfall.

Event 2 involved sampling a total of seven locations (E2-5, E2-6, and E2-7 on Guadalupe Creek, and E2-10, E2-11, E2-12, and E2-13 on Alamitos Creek) during a separate storm event. Measurements were made of suspended sediments, flow rates at ungauged locations, total and dissolved mercury, and methylmercury at each location. Dissolved methylmercury was measured at four of the locations (E2-5, E2-7, E2-12, and E2-13).

Event 3 included sampling the outlets of Alamitos (E2-12) and Guadalupe Creeks (E2-7) on a non-storm day (March 8, 2004) for use in estimating wet season loads. Measurements were made of suspended sediments, flow rates at ungauged locations, total and dissolved mercury, and methylmercury at each location. Dissolved methylmercury was measured at both of the locations (E2-7 and E2-12).

Use of Data in the TMDL: The results from this sampling element were used to provide:

- Relative magnitude of total and dissolved mercury and methylmercury concentrations in tributaries to Guadalupe, Alamitos, and Calero Creeks
- Relative magnitude of total and dissolved mercury and methylmercury concentrations at key locations in Alamitos Creek and Guadalupe Creek
- Relative magnitude of total and dissolved mercury and methylmercury concentrations above and below Almaden Lake
- Wet season load estimates for the above three creeks and their tributaries
- Estimated contribution to estimated loads from areas upstream of key sampling location in Guadalupe, Alamitos, and Calero Creeks.

Results of this sampling element have been used to compare tributary loads to the major creeks and the internally-generated loads from bank erosion and sediment resuspension within the creeks.

4.2 WATER COLUMN SAMPLES

Flows at the sampling locations are provided in Table 4-2. There was limited rainfall at the time of sampling in this part of the watershed, so these samples are more representative of small storm conditions.

The water quality and mercury results are presented in Table 4-3 for both mercury and suspended solids. The field parameters are listed in Table 4-4. The major chemical results are outlined below:

Table 4-2.
Flow Measurements for Element 2 Sampling Locations, Wet Season 2004

Station No.	Station Name	Date	Time	Est Flow, cfs
E2-1	Guadalupe Creek upstream of Cherry Springs Creek	4/14/2004	8:59	6.08
E2-2A	Cherry Springs Creek	4/14/2004	8:48	3.61
E2-2B	Cherry Springs Creek (replicate)	4/14/2004	8:48	rep
E2-3	Pheasant Creek	4/14/2004	8:22	0.75
E2-4	Shannon Creek	4/14/2004	7:58	0.2
E2-5	Guadalupe Creek @ Old Gauge	4/14/2004	7:37	12.6
E2-5	Guadalupe Creek @ Old Gauge	4/20/2004	10:59	17.6
E2-6	Guadalupe Creek below Masson Dam	4/20/2004	7:45	NA
E2-6A	Guadalupe Creek below Masson Dam	4/19/2004	12:30	NA
E2-6B	Guadalupe Creek below Masson Dam (replicate)	4/19/2004	12:30	rep
E2-7	Guadalupe Creek above Almaden Expressway	3/8/2004	11:50	7.05
E2-7	Guadalupe Creek above Almaden Expwy	4/19/2004	0.45	1.01
E2-7A	Guadalupe River above Almaden Expwy	4/20/2004	9:49	2.22
E2-7B	Guadalupe River above Almaden Expwy (replicate)	4/20/2004	9:49	rep
E2-8	Deep Gulch at previously-used site	3/26/2004	11:00	0.21
E2-9	Alamitos Creek @ Almaden Road Bridge near AQC Park	4/20/2004	13:30	4.54
E2-10	Alamitos Creek @ Harry Road	4/19/2004	14:29	13.36
E2-10	Alamitos Creek @ Harry Road	4/20/2004	12:50	2.6
E2-11	Alamitos Creek at Greystone Lane	4/19/2004	13:15	7.06
E2-11	Alamitos Creek @ Greystone Lane	4/20/2004	12:20	2.16
E2-12	Alamitos Creek above Almaden Lake	3/8/2004	12:25	31.68
E2-12	Alamitos Creek above Almaden Lake	4/19/2004	11:50	8.57
E2-12	Alamitos Creek above Almaden Lake	4/20/2004	10:31	11.78
E2-13	Almaden Lake Outlet	4/19/2004	11:27	15.7
E2-13	Almaden Lake Outlet	4/20/2004	10:09	14.96
E2-14	Golf Creek upstream of Alamitos Cr (below Camden Ave)	4/23/2004	1:00	NA
E2-15	Greystone Creek upstream of Alamitos Creek	4/19/2004	13:35	1.31
E2-16	Randol Creek upstream of Alamitos Creek	4/19/2004	14:00	0.2
E2-17	Santa Teresa Creek upstream of Calero Creek	4/14/2004	8:45	0.51
E2-18	Calero Creek @ Harry Road	4/14/2004	7:45	2.56

All flows were estimated from field measurements, since permanent gauges are not present.

Table 4-3.
Aqueous Mercury Speciation in Guadalupe and Alamitos Creeks and Tributaries, Wet Season 2004

					Total Mercury				Methyl Mercury			
Location	Sample ID	Date Sampled	Time	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Guadalupe Cr upstr Cherry Springs Cr	E2-1	4/14/04	8:59	12.7	32.99	4.37	2,254	5.71	0.498	NA	NA	NA
Cherry Springs Creek	E2-2A	4/14/04	8:48	1.1	2.45	1.58	829	5.72	0.021	NA	NA	NA
Cherry Springs Creek	E2-2B	4/14/04	8:48	1.2	31.91*	1.66	26,304*	7.2	0.031	NA	NA	NA
Pheasant Creek	E2-3	4/14/04	8:22	0.9	2.01	0.95	1,247	6.12	0.058	NA	NA	NA
Shannon Creek	E2-4	4/14/04	7:58	1.8	2.74	1.42	754	5.73	0.032	NA	NA	NA
Guadalupe Cr at Old Gauge	E2-5	4/14/04	7:37	13.4	32.08	6.34	1,921	5.48	0.311	0.164	10.97	4.83
Guadalupe Cr at Old Gauge	E2-5	4/20/04	10:59	5.6	28.07	3.11	4,457	6.16	0.355	0.218	24.46	5.05
Guadalupe Cr below Masson Dam	E2-6A	4/19/04	12:30	5.8	14.66	5.02	1,662	5.52	0.456	NA	NA	NA
Guadalupe Cr below Masson Dam	E2-6B	4/19/04	12:30	6.4	15.71	4.67	1,725	5.57	0.489	NA	NA	NA
Guadalupe Cr below Masson Dam	E2-6	4/20/04	7:45	8.6	40.3	4.6	4,151	5.96	0.568	NA	NA	NA
Guadalupe Cr abv Alm Exprwy	E2-7	3/8/04	11:50	8.4	13.82	4.42	1,119	5.4	0.242	0.139	12.26	4.95
Guadalupe Cr abv Alm Exprwy	E2-7	4/19/04	10:50	2	32.75	3.12	14,815	6.68	0.409	0.292	58.5	5.3
Guadalupe Cr abv Alm Exprwy	E2-7A	4/20/04	9:49	2.2	16.06	3.23	5,967	6.27	0.386	0.205	84.19	5.61
Guadalupe Cr abv Alm Exprwy	E2-7B	4/20/04	9:49	2.4	15.87	3.11	5,317	6.23	0.362	0.243	49.58	5.31
Deep Gulch at previous site	E2-8	3/26/04	11:00	1.1	13.41	5.86	7,190	6.09	0.057	NA	NA	NA
Alamitos Cr at bridge near AQCP	E2-9	4/20/04	13:30	9.1	139.5	13.76	13,894	6	0.51	0.334	19.45	4.77
Alamitos Cr at Harry Road	E2-10	4/19/04	14:29	4	97.33	18.67	19,665	6.02	0.486	NA	NA	NA

Table 4-3. (continued)
Aqueous Mercury Speciation in Guadalupe and Alamitos Creeks and Tributaries, Wet Season 2004

					Total Mercury				Methyl Mercury			
Location	Sample ID	Date Sampled	Time	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Alamitos Cr at Harry Road	E2-10	4/20/04	12:50	4.6	125.2	16.72	23,842	6.15	0.553	NA	NA	NA
Alamitos Cr at Greystone Ln	E2-11	4/19/04	13:15	2.2	34.29	11.56	10,332	5.95	0.26	NA	NA	NA
Alamitos Cr at Greystone Ln	E2-11	4/20/04	12:20	2.6	40.32	11.27	11,392	6	0.288	NA	NA	NA
Alamitos Cr abv Alm Lake	E2-12	3/8/04	12:25	3.3	86.49	12.42	22,445	6.26	0.275	0.19	25.76	5.13
Alamitos Cr abv Alm Lake	E2-12	4/19/04	11:50	2.4	39.32	10.94	12,077	6.04	0.31	0.165	61.7	5.57
Alamitos Cr abv Alm Lake	E2-12	4/20/04	10:31	2.8	39.19	9.1	10,942	6.08	0.282	0.147	49.09	5.52
Almaden Lake Outlet	E2-13	4/19/04	11:27	11.2	49.54	4.6	4,030	5.94	0.28	0.049	20.72	5.63
Almaden Lake Outlet	E2-13	4/20/04	10:09	12.3	36.55	4.57	2,611	5.76	0.325	0.042	23.1	5.74
Golf Cr upstr Alm Cr	E2-14	4/23/04	1:00	2.8	37.06	15.26	7,786	5.71	0.426	NA	NA	NA
Greystone Cr upstr Alm Cr	E2-15	4/19/04	13:35	1.1	7.89	4.92	2,700	5.74	0.182	NA	NA	NA
Randol Cr upstr Alm Cr	E2-16	4/19/04	14:00	1.1	3.64	2.43	1,152	5.68	0.119	NA	NA	NA
Santa Teresa Cr upstr Calero Cr	E2-17	4/14/04	8:20	3.8	4.51	1.82	708	5.59	0.15	NA	NA	NA
Calero Cr at Harry Road	E2-18	4/14/04	7:45	16.9	13.46	1.92	683	5.55	0.224	NA	NA	NA

*Considered possible outlier due to lab contamination

Water samples analyzed by Frontier Geosciences Aquatic Geochemistry Group using the following procedure:

total Hg by BrCl digestion + $SnCl_2$ reduction, dual amalgamation CVAFS; CH_3Hg by distillation + aqueous ethylation + GC-CVAFS

Filtered Hg used 0.4 filter.

NA indicates that parameter was not analyzed.

Field replicate samples are indicated by A or B after the sample ID.

Table 4-4.
Field Measurements for Element 2 Water Samples, Wet Season 2004

Station No.	Station Name	Date	Time	pH	Temp. (ºC)	Cond. (uS/cm)	D.O. (mg/L)	% Sat.	Turbidity (NTU)
E2-1	Guadalupe Creek upstream of Cherry Springs Creek	4/14/2004	8:59	7.79	9.67	224	11.38	100.2	16.4
E2-2A	Cherry Springs Creek	4/14/2004	8:48	8.05	9.94	295	11.27	99.9	1.8
E2-2B	Cherry Springs Creek (replicate)	4/14/2004	8:48	rep	rep	rep	rep	rep	rep
E2-3	Pheasant Creek	4/14/2004	8:22	7.61	9.16	261	11.53	100.2	10
E2-4	Shannon Creek	4/14/2004	7:58	7.94	11.59	524	10.49	96.6	3.1
E2-5	Guadalupe Creek @ Old Gauge	4/14/2004	7:37	7.53	9.08	250	11.8	102.4	13.1
E2-5	Guadalupe Creek @ Old Gauge	4/20/2004	10:59	8.11	11.17	270	9.34	85.2	8.4
E2-6	Guadalupe Creek below Masson Dam	4/20/2004	7:45	7.98	10.90	281	8.56	77.60	11.0
E2-6A	Guadalupe Creek below Masson Dam	4/19/2004	12:30	8.07	10.84	281	9.89	89.4	9.6
E2-6B	Guadalupe Creek below Masson Dam (replicate)	4/19/2004	12:30	rep	rep	rep	rep	rep	rep
E2-7	Guadalupe Creek above Almaden Expressway	3/8/2004	11:50	8.66	14.2	317.4	14.95	146.5	14.0
E2-7	Guadalupe Creek above Almaden Expwy	4/19/2004	0.45	8.13	12.78	339.00	12.41	117.40	5.40
E2-7A	Guadalupe River above Almaden Expwy	4/20/2004	9:49	8.19	13.82	359	9.70	93.30	2.0
E2-7B	Guadalupe River above Almaden Expwy (replicate)	4/20/2004	9:49	rep	rep	rep	rep	rep	rep
E2-8	Deep Gulch at previously-used site	3/26/2004	11:00	8.73	12.01	743	11.64	108.3	0.0
E2-9	Alamitos Creek @ Almaden Road Bridge near AQC Park	4/20/2004	13:30	7.71	13.9	297.1	9.75	95.0	14.1
E2-10	Alamitos Creek @ Harry Road	4/19/2004	14:29	8.23	12.74	326	9.31	88.0	26.1
E2-10	Alamitos Creek @ Harry Road	4/20/2004	12:50	8.46	13.5	329.4	10.58	101.8	8.76
E2-11	Alamitos Creek at Greystone Lane	4/19/2004	13:15	8.18	13.91	379	9.87	95.7	1.9
E2-11	Alamitos Creek @ Greystone Lane	4/20/2004	12:20	8.47	15.3	388.9	11.22	112.3	4.22

Table 4-4. (continued)
Field Measurements for Element 2 Water Samples, Wet Season 2004

Station No.	Station Name	Date	Time	pH	Temp. (ºC)	Cond. (uS/cm)	D.O. (mg/L)	% Sat.	Turbidity (NTU)
E2-12	Alamitos Creek above Almaden Lake	3/8/2004	12:25	8.13	14.9	420.9	12.65	125.7	8.5
E2-12	Alamitos Creek above Almaden Lake	4/19/2004	11:50	7.50	14.82	430	8.47	83.9	3
E2-12	Alamitos Creek above Almaden Lake	4/20/2004	10:31	7.58	15.15	477	8.55	85.20	1.6
E2-13	Almaden Lake Outlet	4/19/2004	11:27	8.03	16.53	522	10.02	102.8	7.4
E2-13	Almaden Lake Outlet	4/20/2004	10:09	8.17	16.63	413	10.11	104.00	6.0
E2-14	Golf Creek upstream of Alamitos Cr (below Camden Ave)	4/23/2004	1:00	8.35	20.81	1,294	10.70	120.00	1.90
E2-15	Greystone Creek upstream of Alamitos Creek	4/19/2004	13:35	8.62	18.92	921	11.42	123.3	1.7
E2-16	Randol Creek upstream of Alamitos Creek	4/19/2004	14:00	7.93	14.09	808	8.95	87.3	0.5
E2-17	Santa Teresa Creek upstream of Calero Creek	4/14/2004	8:45	8.26	12.7	520.0	8.97	84.5	14.4
E2-18	Calero Creek @ Harry Road	4/14/2004	7:45	7.57	12.4	293.0	9.36	84.7	44.6

- **Suspended solids.** The ranges for the tributaries and creeks are summarized below:

  - Tributaries to Alamitos Creek: 1.1 to 16.9 mg/L
  - Alamitos Creek: 2.2 to 9.1 mg/L
  - Almaden Lake Outlet: 11.2 to 12.3 mg/L

  - Tributaries to Guadalupe Creek: 0.9 to 1.8 mg/L
  - Guadalupe Creek: 2.0 to 13.4 mg/L

- **Mercury.** The total mercury concentrations in the samples are summarized below:

  - Tributaries to Alamitos Creek: 3.6 to 37.1 ng/L
  - Alamitos Creek: 34.3 to 139.5 ng/L
  - Almaden Lake Outlet: 36.5 to 49.5 ng/L

  - Tributaries to Guadalupe Creek: 2.0 to 2.7 ng/L
  - Guadalupe Creek: 13.8 to 40.3 ng/L

- **Methylmercury.** The total mercury concentrations in the samples are summarized below:

  - Tributaries to Alamitos Creek: 0.06 to 0.43 ng/L
  - Alamitos Creek: 0.26 to 0.55 ng/L
  - Almaden Lake Outlet: 0.28 to 0.32 ng/L

  - Tributaries to Guadalupe Creek: 0.02 to 0.06 ng/L

  - Guadalupe Creek 0.24 to 0.57 ng/L.

- **pH and Dissolved Oxygen.** The water samples from Alamitos and Guadalupe Creeks and their tributaries were alkaline with similar ranges in pH (7.5 to 8.66). There was high dissolved oxygen in all the samples.

Total and dissolved mercury concentrations are shown in Figure 4-2 for both Alamitos and Guadalupe creeks. Alamitos Creek was highest at the bridge below Hacienda Yard (139.5 ng/L at E2-9 on April 20th), and remained high at the Harry Road location (97.3 and 125.2 ng/L at E2-10 on April 19th and 20th). The tributaries entering Alamitos Creek below Harry Road (Golf, Greystone, and Randol) had lower mercury concentrations than the main stem, which is consistent with decreased mercury in Alamitos Creek above Almaden Lake (39.19 and 39.32 ng/L), both measured on the same days.

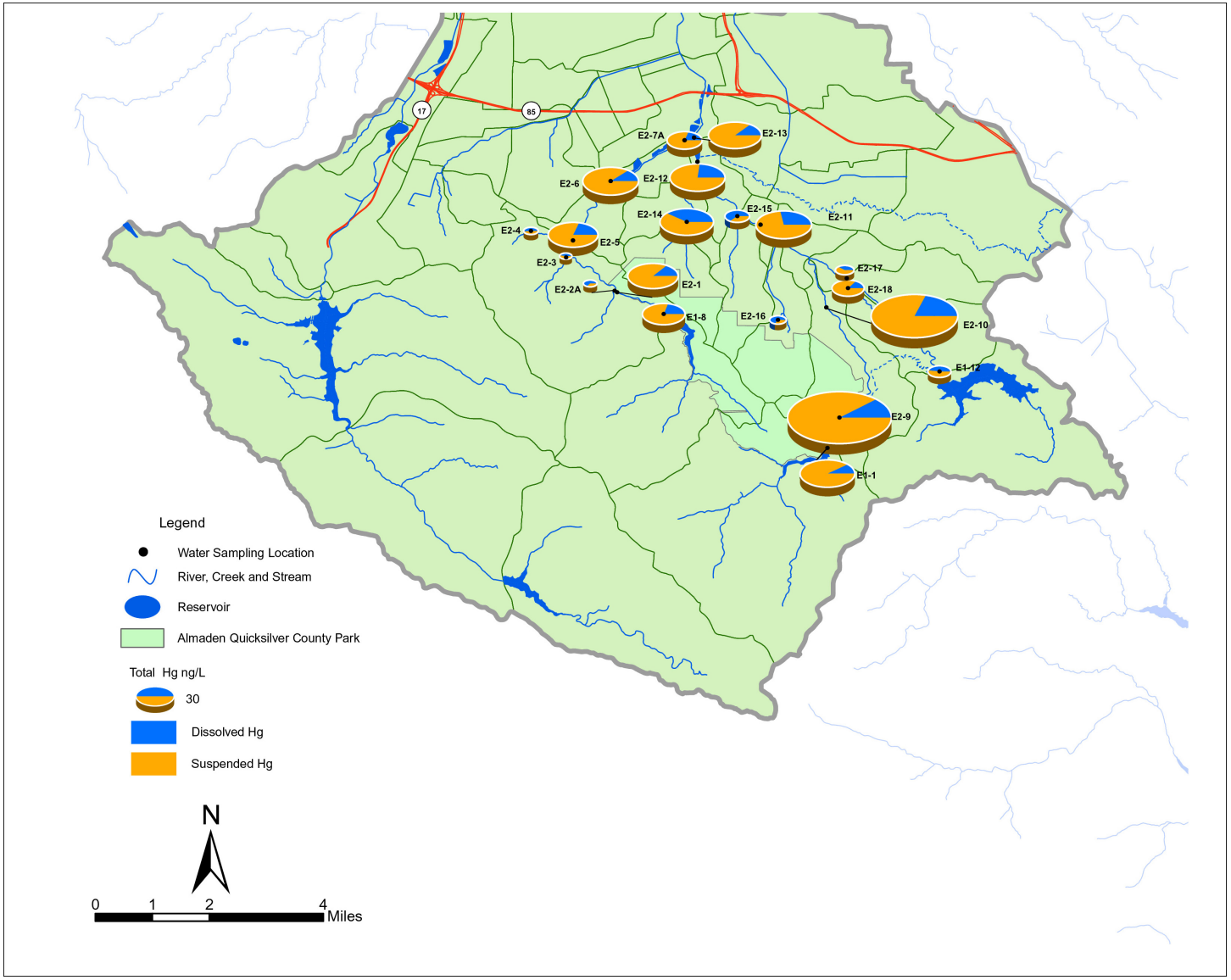


Figure 4-2. Total and dissolved mercury concentrations in Alamitos and Guadalupe Creeks and tributaries.

On the non-storm day (March 8, 2004), the total mercury at the station above Almaden Lake increased to 86.5 ng/L, compared to the Almaden Reservoir outlet (37.5 ng/L). The flow above Almaden Lake was higher (31.9 cfs) on the non-storm day than the other sampling days (8.6 to 11.8 cfs). The reservoir outlet flow was 21.4 cfs on March 8, 2004 and 6.4 cfs on April 19-20. On the two dates when samples were collected above and below Almaden Lake, total mercury was lower in the lake outlet sample. Dissolved mercury was about 50 percent less, indicating that more of the mercury was associated with the particulate fraction.

The highest total mercury concentration in Guadalupe Creek was measured below Masson Dam on April 20th (40.3 ng/L at E2-6), when the upstream sample at the Old Gauge (E2-5) was less (28.1 ng/L). Mercury was almost as high in the main stem of Guadalupe Creek above Cherry Springs Creek (33 ng/L), even though the tributaries between this location and the dam (2.0 ng/L in Pheasant Creek and 2.7 ng/L in Shannon Creek) were lower. These results suggest that mercury is coming from resuspended sediments. The lower Guadalupe Creek had variable mercury concentrations (13.8 ng/L on the non-storm day when the flow was about 7 cfs and 16.1 to 32.7 ng/L for the April sampling events when the flow was 1-2 cfs). Rainfall was minimal in the Guadalupe subwatershed compared to the Alamitos subwatershed.

The total and dissolved mercury concentrations were used to estimate the mercury content of the particulate fraction. This fraction provides an estimate of future sediment when the suspended particles settle. The concentrations were greater than 200 ng/g in all the samples collected at Element 2 locations. As seen in Table 4-3, the total mercury in particulates of Alamitos Creek were elevated, greater than 10,000 ng/g, between the bridge below Hacienda Yard and its confluence with Almaden Lake. The lake outlet samples, however, had lower mercury content (2,611 to 4,030 ng/g), showing that some deposition of the high mercury suspended solids is occurring so that the suspended solids leaving the lake have less mercury. Mercury in particulates increased in Guadalupe Creek from below Masson Dam to the mouth, indicating that sediment with mercury is being resuspended in that reach.

Partition coefficients indicate the tendency of the particulate associated mercury to be sorbed to particles. The partition coefficients are expressed as a ratio of mercury in the solid to liquid phases. A higher Kd value indicates that the mercury is more likely to remain in the solid phase, rather than be dissolved into the water phase. The coefficients were computed for all the samples. The Kd values ranged from 5.4 to 6.68. The range for the main stem of Guadalupe Creek was 5.4 to 6.68, compared to 5.76 to 6.26 for the main stem of Alamitos Creek.

Methylmercury in the tributaries to Alamitos Creek below Harry Road (0.12 ng/L in Randol Creek to 0.43 ng/L in Golf Creek) were higher than the tributaries to Guadalupe Creek (0.02 to 0.06 ng/L), as seen in Figure 4-3. The higher concentrations in the Alamitos tributaries are consistent with the differing land uses, former mining and suburban in the Alamitos tributary subwatersheds and mostly undeveloped open space for the Guadalupe tributaries. In contrast to total mercury,

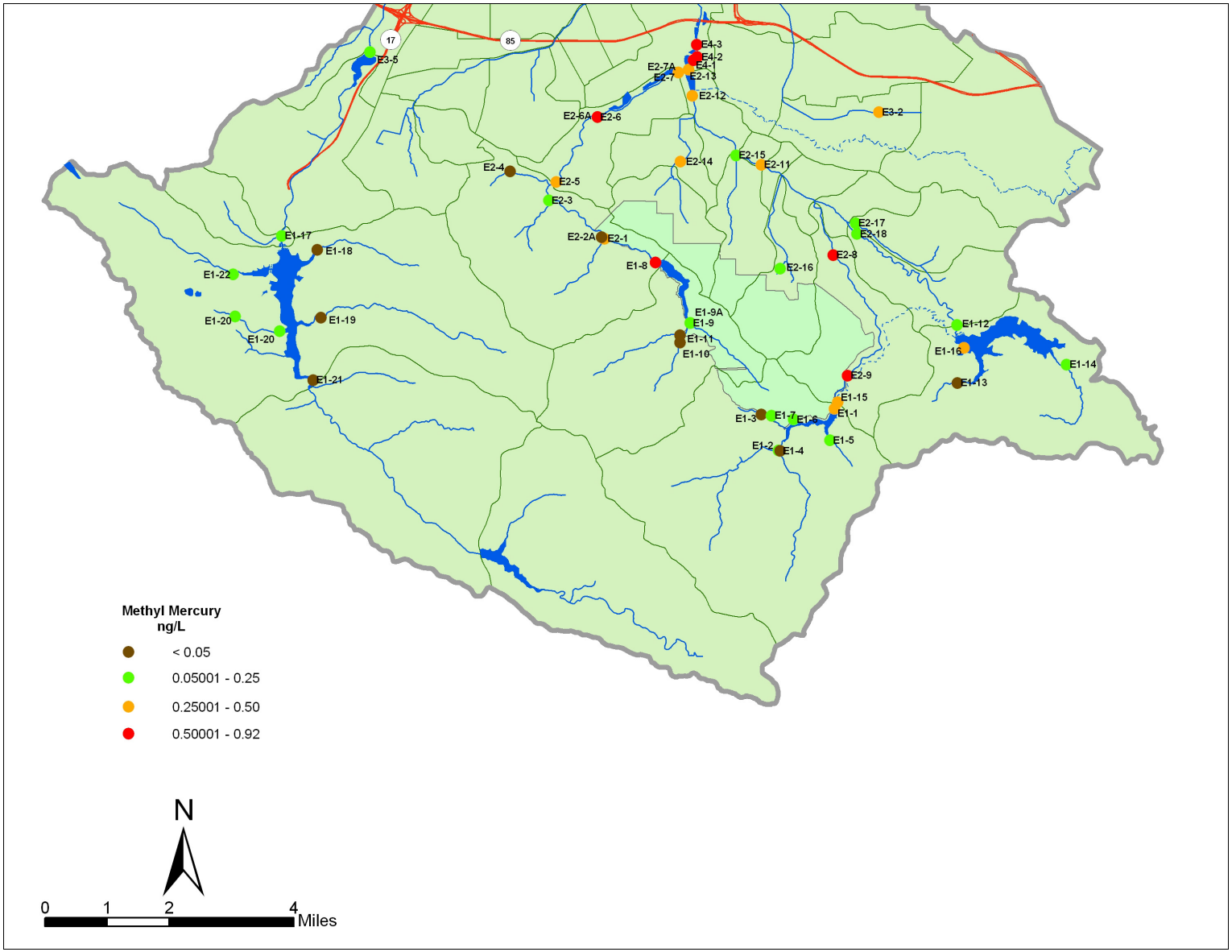


Figure 4-3. Methylmercury concentrations in Alamitos and Guadalupe Creeks and tributaries.

methylmercury in Alamitos Creek did not decrease with distance from the reservoir or mined area (E2-9), as seen in Figure 4-4. The reservoir outlet, when sampled on April 14, had a lower methylmercury concentration (0.29 ng/L). Methylmercury concentrations decreased from Harry Road (0.55 ng/L) to the inlet to Almaden Lake (0.28 to 0.31 ng/L).

A similar methylmercury maximum was observed in Guadalupe Creek below Masson Dam (0.57 ng/L). Both of these locations have higher methylmercury than the tributaries to the reservoirs. In the case of Guadalupe Creek, the methylmercury at the reservoir outlet on April 14 was higher (0.7 ng/L) than the above downstream location. The methylmercury concentrations were lower in the reach of Guadalupe Creek from Cherry Springs Creek to the Old Gauge than the reservoir outlet on April 14 and than at Masson Dam on April 20th . This trend indicates that some in-situ methylation or resuspension of methylmercury-bearing sediment is occurring between the reservoir and Masson Dam. Methylmercury concentrations decrease from below the dam to the mouth of the creek at Almaden Expressway.

4.3 ASSESSMENT OF DATA QUALITY AND CONSTRAINTS

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004a and 2003e) were followed. The QA/QC results for mercury analyses showed that the desired detection limits were achieved, as verified with method blank analyses. The resulting method detection limits (MDLs) in water were 0.20 ng/L for total mercury and 0.018 ng/L for methylmercury. There was one sample considered to be an outlier for total mercury in this data set by the laboratory; sample E2-2B from Cherry Springs Creek. This was a replicate sample collected on 4/14/04. The results for total mercury differed, while the dissolved mercury and methylmercury were similar. Only one bottle is collected for all species in the field, so the problem occurred in the laboratory rather than in the field. Thus, the total mercury and computed particulate fraction for sample E2-2B are not used for data analysis. The other two field replicate samples collected for Element 2 were quite similar.

Data analyses are limited for Element 2, because no sampling occurred during a high flow event. Thus, based on the mercury results for Guadalupe River above and below the drop structure during the large storm on February 26, 2004, higher mercury concentrations in both creeks are likely, especially Alamitos Creek.

4.4 COMPARISON WITH PREVIOUS WATER DATA

The 2004 results are compared to common stations from the Synoptic Survey, wet season monitoring by SCPD in the Almaden Quicksilver County Park (AQCP), and previous Guadalupe Creek sampling for the restoration project.

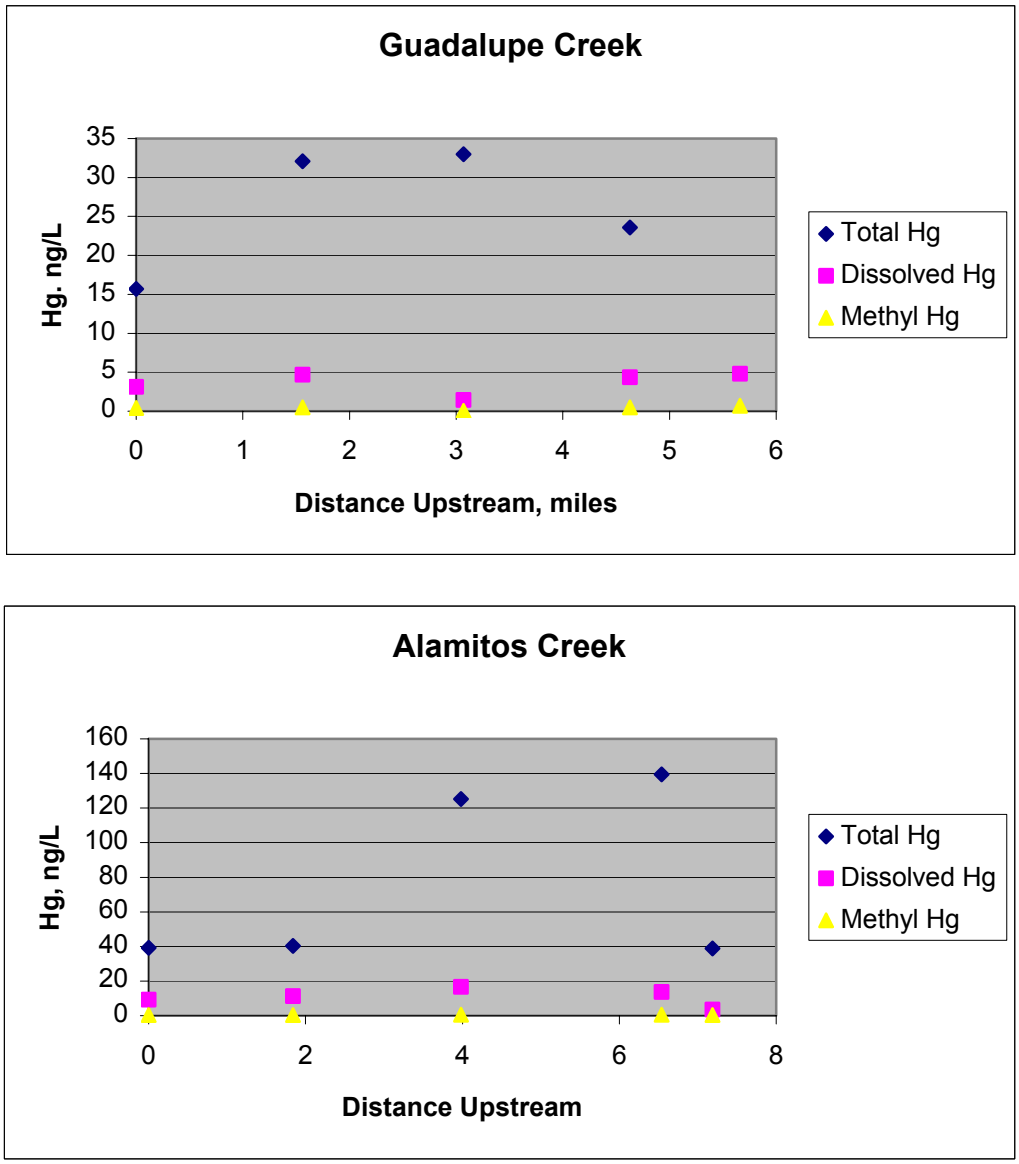


Figure 4-4. Mercury species along Guadalupe and Alamitos Creeks in April 2004

Synoptic Survey. Mercury and other parameters have been measured at some of the same locations sampled in the synoptic survey and the wet season. Results for locations sampled for Alamitos and Guadalupe Creeks are presented in Table 4-5. Total mercury at the reservoir outlets was higher in the wet season than the dry season samples from July 2003, while methylmercury exhibits the opposite trend. Total mercury concentrations increased in the 2004 samples at the mouth of Alamitos Creek, but not for Guadalupe Creek. Lower flows were sampled, as discussed below in the comparison to the 2000 wet season samples for Guadalupe Creek. Methylmercury was higher in the summer for both Alamitos and Guadalupe Creeks, which is expected due to the warmer conditions. The higher total mercury

Table 4-5.
Comparison of Dry and Wet Season Results for Alamitos and Guadalupe Creeks

Location	2004 Sample ID	Total Mercury, ng/L			
		February-00	July-03	March-04	April-04
Al Res Outlet	E1-1	NS	7.49	36.6	38.79
Deep Gulch	E2-8	NS	108.6	13.41	NS
Alamitos Harry	E2-10	NS	435.9		125.2
Alamitos above Lake	E2-12	NS	25.88	86.49	39.32
Guad Res Outlet	E1-8	NS	18.89	77.4	23.56
Guad Cr at Old Gauge	E2-5	82.8	33.15	NS	28.07
Guad Cr Alm Ex	E2-7	74.1	38.9	13.82	32.75

Location	2004 Sample ID	Methylmercury, ng/L			
		February-00	July-03	March-04	April-04
Al Res Outlet	E1-1	NS	4.34	0.328	0.29
Deep Gulch	E2-8	NS	0.2	0.057	NS
Alamitos Harry	E2-10	NS	0.96	NS	0.553
Alamitos above Lake	E2-12	NS	0.306	0.275	0.31
Guad Res Outlet	E1-8	NS	8.27	0.319	0.704
Guad Cr at Old Gauge	E2-5	0.25	5.21	NS	0.355
Guad Cr Alm Ex	E2-7	0.51	0.99	0.242	0.409

concentration in Alamitos Creek at Harry Road in July 2003 is due to higher suspended solids (14 mg/L), compared to the April sample (4.6 mg/L). The reservoir outlet flow at the time of the sampling in July was 5.93 cfs, while the outlet flow on April 20th was 5.3 cfs.

Almaden Quicksilver County Park. In the upper portion of the watershed, water samples have been collected by the Santa Clara Parks Department (2003) during rain

events at Deep Gulch Creek, in addition to other locations. Deep Gulch Creek flows continuously throughout the year, but percolates underground prior to reaching Alamitos Creek in the summer. The total mercury in the 2000-2002 water samples, analyzed using EPA Method 1631, at Deep Gulch Creek ranged from 23.3 to 2,180 ng/L during rain events when the suspended solids concentration was <1 to 7 mg/L. The high mercury concentration was measured during a rain event of 4.3 in/day. In March 2002 during a rain event of 0.59 in/day, the total mercury was 82.9 ng/L. The July 2003 sample at this location for the synoptic survey had suspended solids concentration of <1 mg/L and total mercury of 108.6 ng/L. During a 0.5-inch rain storm in March 2004, the flow in Deep Gulch was estimated to be 0.21 cfs; the total mercury concentration was 13.41 ng/L and methylmercury was 0.057 ng/L. The low mercury is consistent with the low suspended solids (1.1 ng/L) for a smaller rain event.

Guadalupe Creek Restoration. Water samples were collected under both dry and wet conditions at several locations along Guadalupe Creek prior to the restoration project that extended from Masson Dam to Almaden Expressway (Tetra Tech, 2000 and 2001). One of the stations sampled was at the old gauge on Hicks Road. The highest total mercury was measured in February 2000 (82.8 ng/L), when the flow was higher. Methylmercury concentrations were lower in April 2004 than in either the September or February samples from 2000, 1.6 ng/L and 0.25 ng/L, respectively. These results showed that the methylmercury is higher in the dry season, and that total mercury increases at higher flows.

The downstream end of Guadalupe Creek above Almaden Expressway was also sampled on these dates. Total mercury concentrations in the 2004 samples (13.8 ng/L on the non-storm day and 16.1 to 32.7 ng/L for the small storms in April 2004) were within the range of the 2000 samples (11.6 to 74.1 ng/L). The highest total mercury concentration was measured in February 2000 when the suspended solids was 20 mg/L, compared to 2 to 8.4 mg/L in April 2004. Methylmercury was highest in the July 2003 sample (1 ng/L), compared to both the 2000 samples (0.3 to 0.5 ng/L) and the 2004 samples (about 0.4 ng/L). The higher methylmercury in the summer is expected due to the warmer conditions and greater microbiological activity.

5.0 ELEMENTS 3 & 4–MERCURY CONTRIBUTION FROM OTHER SUBWATERSHEDS AND FROM GUADALUPE RIVER

The water sampling results are presented in this section for both Sampling Element 3 and Element 4, since the urban tributaries that make up the Other Watersheds flow into the Guadalupe River.

5.1 PURPOSE AND SAMPLING DESIGN: ELEMENTS 3 AND 4

MERCURY CONTRIBUTION FROM OTHER SUBWATERSHEDS (SAMPLING ELEMENT 3)

Limited data for mercury were previously available for the urban watersheds contributing to the Guadalupe River. Sampling was conducted to answer the following question posed by the Guadalupe Mercury Work Group:

What is the urban runoff contribution to total, dissolved, and methyl mercury loads?

Sampling Element 3 addresses two hypotheses:

1. *Urban runoff concentrations of total, dissolved, and methyl mercury are measurable.*

2. *Urban runoff concentrations of total, dissolved, and methyl mercury vary throughout the watershed, depending on proximity to historical mined areas andd different land-use characteristics.*

Sampling Design: Sampling for Element 3 was conducted in three events between February 27 and April 23, 2004. Event 1 consisted of sampling seven sites on Ross, Canoas, and Los Gatos Creeks. The locations were selected to estimate the mercury

load coming from urban areas and to determine if there are differences along the two longer creeks, Los Gatos and Canoas. Descriptions of the sampling locations and the rationale are provided in Table 5-1; the sampling locations are shown on a map (Figure 5-1). Measurements were made of suspended sediments, flow rates at ungauged locations, total and dissolved mercury, and methylmercury at each location. Dissolved methylmercury was measured at four of the locations (E3-1, E3-4, E3-5, and E3-7).

Table 5-1.
Description of Sampling Stations and Rationale for Element 3: Hg from Other Watersheds to Guadalupe River

Sampling Site Identifier	Sampling Station Description	Rationale
E3-1	Ross Creek upstream of Guadalupe River (gauged)*	Measure Hg concentrations and compare to other tributaries.
E3-2	Canoas Creek at Lean Avenue**	Measure Hg concentrations in upper reach that may receive runoff from previously mined area.
E3-3	Canoas Creek above concrete channel (Dow Drive)	Measure Hg concentrations at end of natural reaches of creek.
E3-4	Canoas Creek upstream of Guadalupe River (gauged)*	Measure Hg concentrations and compare to other tributaries and previous dry season samples. Compare Hg from developed and undeveloped reaches.
E3-5	Los Gatos Creek below Vasona Reservoir Outlet**	Measure Hg concentrations and compare to other reservoir outlets in wet and dry season.
E3-6	Los Gatos Creek at Camden Avenue	Measure Hg concentrations below downstream impoundments to compare to reservoir outlet and mouth.
E3-7	Los Gatos Creek above Guadalupe River (gauged)*	Measure Hg concentrations and compare to other tributaries.

*Sampled three times; **Sampled two times

Event 2 included sampling five locations during a separate storm event. The locations are: the mouth of Ross Creek (E3-1); the mouth of Los Gatos Creek (E3-7) and below Vasona Reservoir on Los Gatos Creek (E3-5); the mouth of Canoas Creek (E3-4) and in the upper reach of Canoas Creek (E3-2). The sample from Ross Creek was sampled upstream on a later day than the other locations, since there was no flow at the original location on the sampling day. Measurements were made of suspended sediments, flow rates at ungauged locations, total and dissolved mercury, and methylmercury at each location. Dissolved methylmercury was measured at four of the locations (E3-1, E3-4, E3-5, and E3-7).

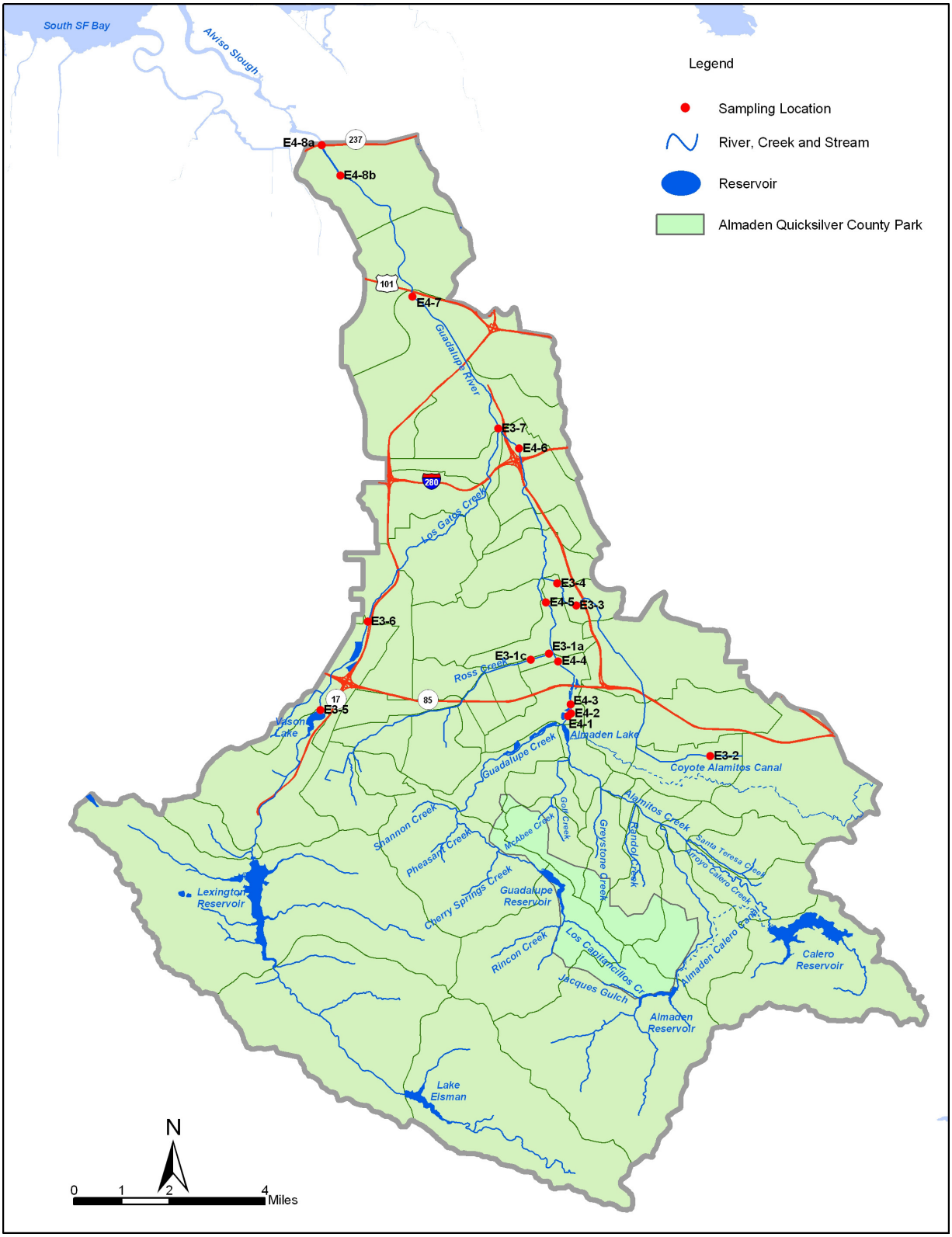


Figure 5-1. Sampling Locations for Elements 3 and 4: Guadalupe River and Major Tributaries.

Event 3 consisted of sampling three locations during a non-storm day (March 8, 2004) for use in estimating wet season loads. The locations are: the mouths of Ross Creek (E3-1), Los Gatos Creek (E3-7), and Canoas Creek (E3-4).

Use of Data in the TMDL: The results from Sampling Element 3 Other Subwatersheds have been used to provide:

- Relative magnitude of total and dissolved mercury and methylmercury concentrations in Ross, Los Gatos, and Canoas Creeks and the estimated fraction due to urban runoff
- Wet season load estimates for the above tributaries to the Guadalupe River
- Comparison of the percentage of load attributable to atmospheric deposition to that of urban runoff.

Because of the increased impervious surfaces in the urban areas, the volume of runoff is often larger than the volume from the areas with historic mines. Therefore, mercury loads from urban areas need to be estimated for the TMDL. In addition, results have been used to determine if there is a measurable contribution of mines to mercury in Canoas Creek.

HG TRANSPORT IN GUADALUPE RIVER (SAMPLING ELEMENT 4)

Mercury in the Guadalupe River is transported to San Francisco Bay. Sampling was conducted to answer the following question posed by the Guadalupe Mercury Work Group:

What is the load of total, dissolved, and methyl mercury to the Guadalupe River from its tributaries and, subsequently, to the Bay?

Sampling Element 4 addresses four hypotheses:

1. *Total mercury concentrations and load from Alamitos Creek are significantly reduced by Lake Almaden.*

2. *Total mercury concentrations and load from Guadalupe Creek are significantly reduced by the Alamitos Drop Structure.*

3. *Dissolved and methyl mercury concentrations and loads from Alamitos and Guadalupe Creeks during storm events are not affected by these features.*

4. *Total, dissolved, and methyl mercury concentrations in the upper Guadalupe River are diluted by other flows between the Alamitos Drop Structure and the Bay.*

Sampling Design: Sampling Element 4 was conducted in three events between February 26 and April 20, 2004. Event 1 consisted of sampling eight locations on the Guadalupe River during a winter storm event to characterize the wet season runoff. Descriptions of the sampling locations and the rationale are provided in Table 5-2; the sampling locations are shown on a map (Figure 5-1). Measurements were made of suspended sediments, total and dissolved mercury, and methylmercury at each location. Dissolved mercury and dissolved methylmercury were measured at two of the locations (E4-7 and E4-8).

Event 2 involved sampling the same 8 locations on the Guadalupe River during a second storm event to characterize variability. Measurements were made of suspended sediments, total and dissolved mercury and methylmercury at each location. Dissolved methylmercury was measured at three of the locations (E4-2, E4-7, and E4-8).

Event 3 consisted of sampling four locations on a non-storm day (March 8, 2004) for use in estimating base loads during the wet season. The locations were: Guadalupe River below the Alamitos Drop Structure (E4-2), upstream of Ross Creek (E4-4), upstream of Canoas Creek (E4-5), and at the flow gauging station at Highway 101 (E4-7). Measurements were made of suspended sediments, total and dissolved mercury, and methylmercury at each location. Dissolved methylmercury was measured at five of the locations (E4-2, E4-4, E4-5, E4-7 and E4-8).

Use of Data in the TMDL: The results from Sampling Element 4 have been used to provide:

- Relative magnitude of total and dissolved mercury and methylmercury above and below the Alamitos Drop Structure.
- Relative magnitude of concentrations of total, dissolved, and methyl mercury at key locations in Guadalupe River that segment the major subwatersheds.
- Relative magnitude of concentrations of total, dissolved, and methyl mercury above and below the sediment deposition area (downstream of Highway 101 at Highway 237).
- Wet season load estimates for the Guadalupe River to the sediment deposition area and to the Bay.
- Estimates of contribution to loads from areas upstream of each key sampling location in Guadalupe River.

The results of this sampling element will be used to estimate the mercury load to South San Francisco Bay.

Table 5-2.
Description of Sampling Stations and Rationale for Element 4: Hg Transport in Guadalupe River

Sampling Site Identifier	Sampling Station Description	Rationale
E4-1	Guadalupe River above Alamitos Drop Structure**	Measure and compare Hg concentrations above and below drop structure.
E4-2	Guadalupe River below Alamitos Drop Structure**	
E4-3	Guadalupe River at Blossom Hill Road**	Measure Hg concentrations and compare to upstream reaches.
E4-4	Guadalupe River upstream of Ross Creek inflow (near gauge)*	Measure Hg concentrations and compare to upstream reaches. Estimate relative contribution of Hg from urban and non-urban areas.
E4-5	Guadalupe River upstream of Canoas Creek inflow (gauged)*	
E4-6	Guadalupe River at San Carlos St (above Los Gatos Creek)**	
E4-7	Guadalupe River at Highway 101 (gauged)*	Measure Hg concentrations and compare to results at Highway 101. Estimate Hg contribution to SF Bay.
E4-8	Guadalupe River at Highway 237**	Measure Hg concentrations and compare to results at Highway 101 from SFEI. Estimate Hg contribution to SF Bay.
*Sampled three times; **Sampled two times		

5.2 WATER COLUMN SAMPLE RESULTS

Water samples were collected at seven locations along Ross Creek, Canoas Creek, and Los Gatos Creek, and at eight locations along the Guadalupe River. The sampling for these two elements was conducted on the same day or within a few days to allow comparisons among the stations.

The flows for the tributaries and river are presented in Table 5-3. The flows on the days sampled ranged from 29 cfs on April 20, 2004 to 807 cfs on February 26, 2004 when the river above and below the Alamitos Drop Structure and at Highway 101 were sampled. Thus, both high and low flow events were sampled for the main stem of the Guadalupe River. The urban creeks and the intermediate river locations were sampled the next day (2/27/04) when the flow at the Highway 101 gauge had decreased to 348.7 cfs.

Flows in the urban tributaries were large compared to the upstream tributaries, but still less than the main stem. Los Gatos Creek had higher flows than either Ross or Canoas Creeks on the same day. The contribution of the urban creeks to flow in the Guadalupe River is shown in Figure 5-2. The flow contribution of Los Gatos varied from less than 5 percent to almost 25 percent. Ross Creek is above the gauge on the Guadalupe River at Almaden Expressway; its flow varied from 0.3 to 12.5 cfs. The other component identified in the graph consists of direct runoff to the river.

The suspended solids and mercury results are presented in Table 5-4. Field parameters were also measured, as shown in Table 5-5. Sulfate and sulfide were analyzed at two locations on the Guadalupe River, below the Alamitos Drop Structure (E4-2) and at the Highway 101 gauge (E4-7). The results are summarized below:

- **Suspended Solids.** The suspended solids concentrations in the urban creeks and Guadalupe River are summarized below:
  - Ross Creek: 1.1 to 24.5 mg/L
  - Canoas Creek: 2.7 to 45.6 mg/L
  - Los Gatos Creek: 2.5 to 90.4 mg/L
  - Guadalupe River main stem: 5.0 to 118.6 mg/L.

- **Mercury.** Total mercury in the urban creeks and Guadalupe River are summarized below:
  - Ross Creek: 5.30 to 18.47 ng/L
  - Canoas Creek: 4.14 to 27.97 ng/L
  - Los Gatos Creek: 2.04 to 29.83 ng/L
  - Guadalupe River main stem: 14.48 to 464.6 ng/L

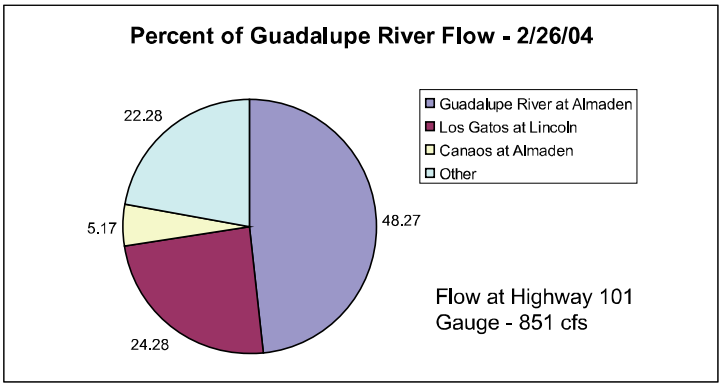
- **Sulfate and Sulfide.** Sulfate was measured at two locations on the Guadalupe River. The sulfate concentrations were 34 mg/L below the Alamitos Drop Structure and 86 mg/L at the Highway 101 gauge. Sulfide concentrations were less than 0.01 mg/L at both locations.

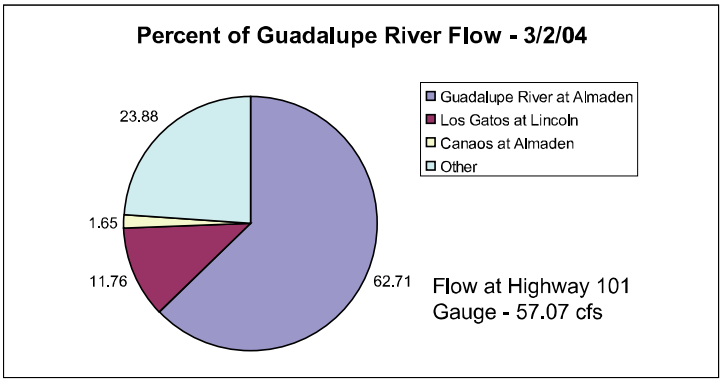
Table 5-3.
Flow Measurements at Elements 3 and 4 Sampling Locations, Wet Season 2004

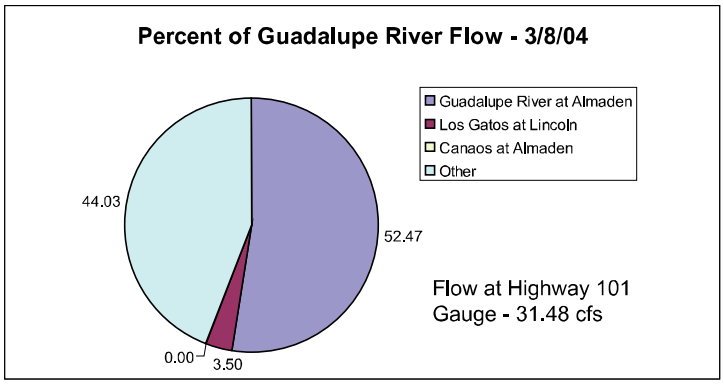
Station No.	Station Name	Date	Time	Gauged Flows, cfs	Est. Flows, cfs
E3-1A	Ross Creek upstream of Guadalupe River	2/27/2004	14:00	12.5	
E3-1B	Ross Creek upstream of Guadalupe River (replicate)	2/27/2004	14:00	rep	
E3-1	Ross Creek upstream of Guadalupe River	3/8/2004	10:45	1.2	
E3-1	Ross Creek upstream of River (below Cherry Ave.)	4/23/2004	11:30	0.30	
E3-2	Canoas Creek at Lean Avenue	2/27/2004	14:45		1.5
E3-2	Canoas Creek at Lean Ave	4/20/2004	11:40		0.06
E3-3	Canoas Creek at Dow Drive	2/27/2004	13:00		4.12
E3-4	Cannoas Creek upstream of Guadalupe River	2/27/2004	12:05	7.4	
E3-4	Canoas Creek upstream of Guadalupe River	3/8/2004	9:19	0.7	
E3-4	Canoas Creek upstream of Guadalupe River	4/20/2004	9:25	1	
E3-5	Los Gatos Creek below Vasona Reservoir Outlet	2/27/2004	8:35	spilling	79.2
E3-5	Los Gatos Creek below Vasona Reservoir Outlet	4/20/2004	8:10		18.72
E3-6	Los Gatos Creek at Camden Avenue	2/27/2004	9:30		9.92
E3-7	Los Gatos Creek above Guadalupe River	2/27/2004	10:20	18.1	
E3-7	Los Gatos Creek above Guadalupe River	3/8/2004	8:45	2.7	
E3-7	Los Gatos Creek upstream of Guadalupe River	4/20/2004	8:50	31.8	
E4-1	Guadalupe River above Almaden Drop Structure	2/26/2004	8:50		NA
E4-1	Guadalupe River above Alamitos Drop Structure	4/20/2004	8:40		NA
E4-2	Guadalupe River below Almaden Drop Structure	2/26/2004	9:25		spilling
E4-2	Guadalupe River below Almaden Drop Structure	3/8/2004	11:30	20.87	NA
E4-2	Guadalupe River below Alamitos Drop Structure	4/20/2004	9:08	9.51	NA
E4-3	Guadalupe River at Blossom Hill Road	2/27/2004	9:15	57	
E4-3	Guadalupe River at Blossom Hill Road	4/20/2014	8:20	9.6	
E4-4	Guadalupe River upstream of Ross Creek Inflow	2/27/2004	10:10		NA
E4-4	Guadalupe River upstream of Ross Creek Inflow	3/8/2004	11:10		30.96
E4-4	Guadalupe River upstream of Ross Creek Inflow	4/20/2004	10:40		9.18
E4-5	Guadalupe River upstream of Canoas Creek Inflow	2/27/2004	10:30	174.6	
E4-5	Guadalupe River upstream of Canoas Creek Inflow	3/8/2004	9:42	31.5	NA
E4-5	Guadalupe River upstream of Canoas Creek Inflow	4/20/2004	9:55	9.9	

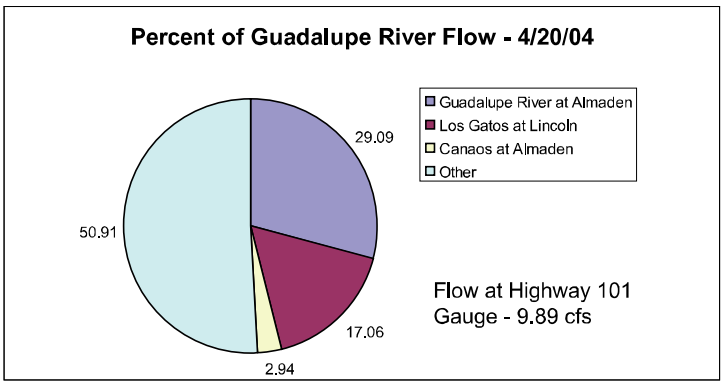
Table 5-3. (continued)
Flow Measurements at Elements 3 and 4 Sampling Locations, Wet Season 2004

Station No.	Station Name	Date	Time	Gauged Flows, cfs	Est. Flows, cfs
E4-6	Guadalupe River at San Carlos St.	2/27/2004	11:10		NA
E4-6	Guadalupe River at San Carlos Street	4/20/2004	11:55		NA
E4-7	Guadalupe River at Highway 101	2/26/2004	10:25	807	
E4-7	Guadalupe River at Hwy 101	4/20/2004	12:25	29.00	
E4-7A	Guadalupe River at Highway 101	3/8/2004	15:10	45	
E4-7B	Guadalupe River at Highway 101 (replicate)	3/8/2004	15:10		rep
E4-8	Guadalupe River at HWY 237	2/27/2004	12:00		NA
E4-8	Guadalupe River at Hwy 237	4/20/2004	13:00		NA









Flows used are average daily flows

Figure 5-2. Percent Flow Contributed by Urban Creeks to Guadalupe River at Highway 101 Gauge.

Table 5-4.
Aqueous Mercury Speciation in Guadalupe River System, Wet Season 2004

					Total Mercury				Methyl Mercury			
Location	Sample ID	Date Sampled	Time	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Ross Creek upstr Guadalupe River	E3-01	3/8/04	10:45	4	5.3	1.97	833	5.63	0.062	0.016	11.5	5.86
Ross Creek upstr Guadalupe River	E3-01-A	2/27/04	14:00	24.5	18.47	6.09	505	4.92	0.229	0.089	5.71	4.81
Ross Creek upstr Guadalupe River	E3-01-B	2/27/04	14:00	22.9	16.24	6.64	419	4.8	0.176	0.101	3.28	4.51
Ross Creek upstr Guadalupe River	E3-01	4/23/04	11:30	1.1	5.35	2.83	2,400	5.93	0.36	0.248	106.7	5.63
Canoas Cr at Lean Ave	E3-02	2/27/04	14:45	45.6	25.21	18.99	136	3.86	0.31	NA	NA	NA
Canoas Cr at Lean Ave	E3-02	4/20/04	11:40	3.9	27.97	14.14	3,546	5.4	0.346	NA	NA	NA
Canoas Cr at Dow Drive	E3-03	2/27/04	13:00	17.7	18.08	9.09	508	4.75	0.185	NA	NA	NA
Canoas Cr upstr Guadalupe River	E3-04	2/27/04	12:05	12	12.28	8.12	347	4.63	0.184	0.13	4.5	4.54
Canoas Cr upstr Guadalupe River	E3-04	3/8/04	9:19	2.7	4.14	2.15	751	5.54	0.004	ND	NC	NC
Canoas Cr upstr Guadalupe River	E3-04	4/20/04	9:25	9.4	7.01	2.2	512	5.37	0.153	0.016	14.59	5.96
Los Gatos Cr below Vasona Res	E3-05	2/27/04	8:35	90.4	29.83	5.23	272	4.72	0.231	0.044	2.07	4.67
Los Gatos Cr below Vasona Res	E3-05	4/20/04	8:10	22.9	5.85	0.98	213	5.34	0.07	0.011	2.58	5.37

Table 5-4. (continued)
Aqueous Mercury Speciation in Guadalupe River System, Wet Season 2004

Location	Sample ID	Date Sampled	Time	TSS mg/L	Total Mercury				Methyl Mercury			
					Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Los Gatos Cr at Camden Ave	E3-06	2/27/04	9:30	74.8	28	3.97	321	4.91	0.176	NA	NA	NA
Los Gatos Cr upstr Gaudalupe River	E3-07	2/27/04	10:20	49.3	21.81	4.76	346	4.86	0.159	0.038	2.45	4.81
Los Gatos Cr upstr Gaudalupe River	E3-07	3/8/04	8:45	2.5	2.04	0.99	420	5.63	0.017	0.003	5.6	6.27
Los Gatos Cr upstr Gaudalupe River	E3-07	4/20/04	8:50	2.9	2.85	0.64	762	6.08	0.015	0.004	3.79	5.98
Guadalupe River abv ALM DS	E4-01	2/26/04	8:50	96.4	394.4	20.05	3,883	5.29	0.915	NA	NA	NA
Guadalupe River abv ALM DS	E4-01	4/20/04	8:40	12.2	50.9	4.74	3,784	5.9	0.464	NA	NA	NA
Guadalupe River below ALM DS	E4-02	2/26/04	9:25	96.1	464.6	19.26	4,634	5.38	0.737	NA	NA	NA
Guadalupe River below ALM DS	E4-02	3/8/04	11:30	5	78.6	11.47	13,426	6.07	0.309	0.136	34.6	5.41
Guadalupe River below ALM DS	E4-02	4/20/04	9:08	13.1	65.75	4.91	4,644	5.98	0.505	0.078	32.6	5.62
Guadalupe River at Blossom Hill Rd	E4-03	2/27/04	9:15	49.2	258.4	20.42	4,837	5.37	0.563	NA	NA	NA
Guadalupe River at Blossom Hill Rd	E4-03	4/20/04	8:20	12.9	352.3	4.57	27,061	6.77	0.632	NA	NA	NA
Guadalupe River upstr Ross Cr	E4-04	2/27/04	10:10	49.6	263	22.22	4,854	5.34	0.649	NA	NA	NA

Table 5-4. (continued)
Aqueous Mercury Speciation in Guadalupe River System, Wet Season 2004

Location	Sample ID	Date Sampled	Time	TSS mg/L	Total Mercury				Methyl Mercury			
					Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Guadalupe River upstr Ross Cr	E4-04	3/8/04	11:10	6.5	66	11.93	8,318	5.84	0.292	0.154	21.23	5.14
Guadalupe River upstr Ross Cr	E4-04	4/20/04	10:40	9.3	49.62	4.46	4,856	6.04	0.539	NA	NA	NA
Guadalupe River upstr Canoas Cr	E4-05	2/27/04	10:30	46.1	242.7	20.19	4,827	5.38	0.603	NA	NA	NA
Guadalupe River upstr Canoas Cr	E4-05	3/8/04	9:42	7.7	71.43	9.17	8,086	5.95	0.302	0.149	19.87	5.13
Guadalupe River upstr Canoas Cr	E4-05	4/20/04	9:55	7.1	40.38	4.27	5,122	6.08	0.533	NA	NA	NA
Guadalupe River at San Carlos St	E4-06	2/27/04	11:10	47.6	226.5	15.88	4,425	5.45	0.594	NA	NA	NA
Guadalupe River at San Carlos St	E4-06	4/20/04	11:55	7.9	40.74	4.63	4,600	6	0.595	NA	NA	NA
Guadalupe River at Hwy 101	E4-07	2/26/04	10:25	118.6	363.9	11.67	2,970	5.41	0.748	0.101	5.46	4.73
Guadalupe River at Hwy 101	E4-07-A	3/8/04	15:10	5.2	19.58	3.84	3,027	5.9	0.158	0.088	13.46	5.18
Guadalupe River at Hwy 101	E4-07-B	3/8/04	15:10	5.3	22.09	3.18	3,568	6.05	0.164	0.093	13.4	5.16
Guadalupe River at Hwy 101	E4-07	4/20/04	12:25	6.6	14.48	1.63	1,962	6.08	0.23	0.061	25.8	5.63
Guadalupe River at Hwy 237	E4-08	2/27/04	12:00	74.4	182.5	10.32	2,314	5.35	0.506	0.082	5.7	4.84

Table 5-4. (continued)
Aqueous Mercury Speciation in Guadalupe River System, Wet Season 2004

Location	Sample ID	Date Sampled	Time	TSS mg/L	Total Mercury				Methyl Mercury			
					Unfiltered ng/L	Filtered ng/L	Particulate Hg ng/g	log Kd	Unfiltered ng/L	Filtered ng/L	Particulate MeHg ng/g	log Kd
Guadalupe River at Hwy 237	E4-08	4/20/04	1:00	17.7	32.83	1.93	1,746	5.96	0.294	0.072	12.54	5.24

analyzed by Frontier Geosciences Aquatic Geochemistry Group

total Hg by BrCl digestion + $SnCl_2$ reduction, dual amalgamation CVAFS; CH_3Hg by distillation + aqueous ethylation + GC-CVAFS

Filtered Hg used 0.4 m filter.

NA indicates that parameter was not analyzed; ND indicates not detected at MDL of 0.02 ng/L; NC indicates not computed.

Field replicate samples are indicated by A or B after the sample ID.

Table 5-5.
Field Measurements for Element 3 and 4 Water Samples, Wet Season 2004

Station No.	Station Name	Date	Time	pH	Temp. (ºC)	Cond. (uS/cm)	D.O. (mg/L)	% Sat.	Turbidity (NTU)
E3-1A	Ross Creek upstream of Guadalupe River	2/27/2004	14:00	8.13	13.6	337.0	10.18	98.1	42.7
E3-1B	Ross Creek upstream of Guadalupe River (replicate)	2/27/2004	14:00	rep	rep	rep	rep	rep	rep
E3-1	Ross Creek upstream of Guadalupe River	3/8/2004	10:45	8.62	15.8	641.0	11.98	122.0	11.8
E3-1	Ross Creek upstream of River (below Cherry Ave.)	4/23/2004	11:30	8.66	17.50	611	7.45	77.70	1.30
E3-2	Canoas Creek at Lean Avenue	2/27/2004	14:45	8.74	14.7	257.4	13.13	129.4	96.0
E3-2	Canoas Creek at Lean Ave	4/20/2004	11:40	9.35	21.5	491.3	14.25	162.5	19.2
E3-3	Canoas Creek at Dow Drive	2/27/2004	13:00	8.34	15.6	417.4	13.65	137	49.7
E3-4	Cannoas Creek upstream of Guadalupe River	2/27/2004	12:05	8.33	14.5	339.4	13.35	131	46.1
E3-4	Canoas Creek upstream of Guadalupe River	3/8/2004	9:19	8.66	13.77	870	19.83*	192.2*	1
E3-4	Canoas Creek upstream of Guadalupe River	4/20/2004	9:25	8.24	16.6	824	8.99	92.6	17.7
E3-5	Los Gatos Creek below Vasona Reservoir Outlet	2/27/2004	8:35	7.60	11.8	195.0	10.66	98.4	163
E3-5	Los Gatos Creek below Vasona Reservoir Outlet	4/20/2004	8:10	7.52	13.9	289.1	9.70	95.0	32.3
E3-6	Los Gatos Creek at Camden Avenue	2/27/2004	9:30	7.75	11.6	206.6	10.58	98	130
E3-7	Los Gatos Creek above Guadalupe River	2/27/2004	10:20	7.59	12.2	256.6	10.12	94.2	72.1
E3-7	Los Gatos Creek above Guadalupe River	3/8/2004	8:45	7.77	15.55	638	8.93	89.8	3.3
E3-7	Los Gatos Creek upstream of Guadalupe River	4/20/2004	8:50	7.80	16.4	641	8.77	89.9	4.24
E4-1	Guadalupe River above Almaden Drop Structure	2/26/2004	8:50	7.55	12.0	267.0	8.9	81	160
E4-1	Guadalupe River above Alamitos Drop Structure	4/20/2004	8:40	8.17	16.35	516	9.44	96.60	4.50
E4-2	Guadalupe River below Almaden Drop Structure	2/26/2004	9:25	7.65	11.9	265.7	10.25	94.5	157

Table 5-5. (continued)
Field Measurements for Element 3 and 4 Water Samples, Wet Season 2004

Station No.	Station Name	Date	Time	pH	Temp. (ºC)	Cond. (uS/cm)	D.O. (mg/L)	% Sat.	Turbidity (NTU)
E4-2	Guadalupe River below Almaden Drop Structure	3/8/2004	11:30	8.11	15.68	438	9.49	95.7	7
E4-2	Guadalupe River below Alamitos Drop Structure	4/20/2004	9:08	8.21	16.19	512	8.78	90.00	10.00
E4-3	Guadalupe River at Blossom Hill Road	2/27/2004	9:15	7.86	11.55	267	9.4	86.6	70
E4-3	Guadalupe River at Blossom Hill Road	4/20/2014	8:20	8.14	15.77	509	8.00	80.8	6.4
E4-4	Guadalupe River upstream of Ross Creek Inflow	2/27/2004	10:10	7.86	11.64	270	8.8	81.1	70.6
E4-4	Guadalupe River upstream of Ross Creek Inflow	3/8/2004	11:10	8.23	15.0	435.4	10.04	99.6	18.5
E4-4	Guadalupe River upstream of Ross Creek Inflow	4/20/2004	10:40	8.33	16.6	520	9.11	93.8	11.3
E4-5	Guadalupe River upstream of Canoas Creek Inflow	2/27/2004	10:30	7.91	11.58	272	9.14	83.9	63.7
E4-5	Guadalupe River upstream of Canoas Creek Inflow	3/8/2004	9:42	8	14.41	430	9.13	89.6	7.7
E4-5	Guadalupe River upstream of Canoas Creek Inflow	4/20/2004	9:55	8.23	17.0	524	8.00	83.0	12.1
E4-6	Guadalupe River at San Carlos St.	2/27/2004	11:10	7.97	11.52	260	9.21	84.3	63.8
E4-6	Guadalupe River at San Carlos Street	4/20/2004	11:55	7.90	15.68	465	7.14	71.90	9.70
E4-7	Guadalupe River at Highway 101	2/26/2004	10:25	7.68	12.2	247.5	9.35	87.0	147
E4-7	Guadalupe River at Highway 101	4/20/2004	12:25	7.65	16.99	738	7.15	74.20	6.60
E4-7A	Guadalupe River at Highway 101	3/8/2004	15:10	7.87	18.18	704	9.21	97.8	3.9
E4-7B	Guadalupe River at Highway 101 (replicate)	3/8/2004	15:10	rep	rep	rep	rep	rep	rep
E4-8	Guadalupe River at Highway 237	2/27/2004	12:00	7.74	12.45	332	8.18	76.8	82.4
E4-8	Guadalupe River at Highway 237	4/20/2004	13:00	7.68	16.64	778	6.27	64.30	14.80

*Anomalous DO reading. However, the probe and every object within the creek was covered with tiny bubbles that resembled a carbonated beverage. The meter checked out fine (i.e., DO membrane was in good shape and the probe calibration was within specs)

- **pH.** The pH of the urban creeks ranged from 7.52 to 9.35. The pH above the drop structure was 7.55 to 8.17, and 7.65 to 8.33 in the locations further downstream.

- **Dissolved Oxygen.** The dissolved oxygen was high in all the locations for both the urban creeks and the river. At Highway 237, the dissolved oxygen decreased from 8.18 mg/L in the high flow sample to 6.27 mg/L in the low flow sample. The conductivity also increased from 332 to 778 μS/cm.

Los Gatos Creek contributed higher suspended solids to the river than Ross or Canoas Creek, particularly when Vasona Reservoir spilled, as it did on February 26th (see photograph at time of sampling – Figure 5-3). Los Gatos Creek contributed less total mercury and methylmercury than the tributaries influenced by mining, Alamitos and Guadalupe Creeks (Figure 5-4). The three urban creeks had similar maximum total mercury concentrations during the large flow event in February 2004, with the highest measured concentration below the Vasona Reservoir in Los Gatos Creek (Figure 5-5). Los Gatos Creek had higher methylmercury below Vasona Reservoir and upstream of this reservoir than in the downstream locations on the same sampling day.

One of the questions that the Element 3 sampling was designed to address was that Canoas Creek was influenced by past mining and mercury deposits in its watershed. Because the total mercury concentrations in Canoas Creek were within the range of the other urban creeks and were similar to other creeks not influenced by mining (e.g. Santa Teresa and Greystone Creeks), there is no measurable influence from past mining in Canoas Creek. The peak methylmercury concentrations in Canoas were similar to those in Ross Creek: 0.36 ng/L in Ross Creek and 0.35 ng/L in Canoas Creek at Lean Avenue.

Mercury along the Guadalupe River and urban creeks are compared for a large and small storm and a non-storm day in Figures 5-6 through 5-8. In all three events, total mercury was higher in the upper part of the river near the Alamitos Drop Structure, compared to the lower part by Highways 101 and 237. The suspended solids were higher in the large storm in February (46.1 to 118.6 mg/L), compared to the low flow event in April (7.1 to 17.7 mg/L) and the non-storm event (5 to 7.7 mg/L). With the exception of the sampling location at Blossom Hill Road, all forms of mercury along the river were highest in the large storm event, including methylmercury (Figure 5-9). A possible explanation for the increase in total mercury concentration at Blossom Hill Road in the April 20th sample, after the large storm event, is that sediment can spill over the Alamitos Drop Structure during high flow events, resulting in sediment below the drop structure as seen in the photograph (Figure 5-10). Succeeding high flow events could transport part of this sediment downstream where it could be resuspended. In addition, the large flows at the time of spilling would transport higher loads of suspended solids, which would then take time to settle in the low gradient, less turbulent reach of the river below the drop structure.



Figure 5-3. Los Gatos Creek on 2/27/04 at high flow a) at Vasona Dam and b) below on dam

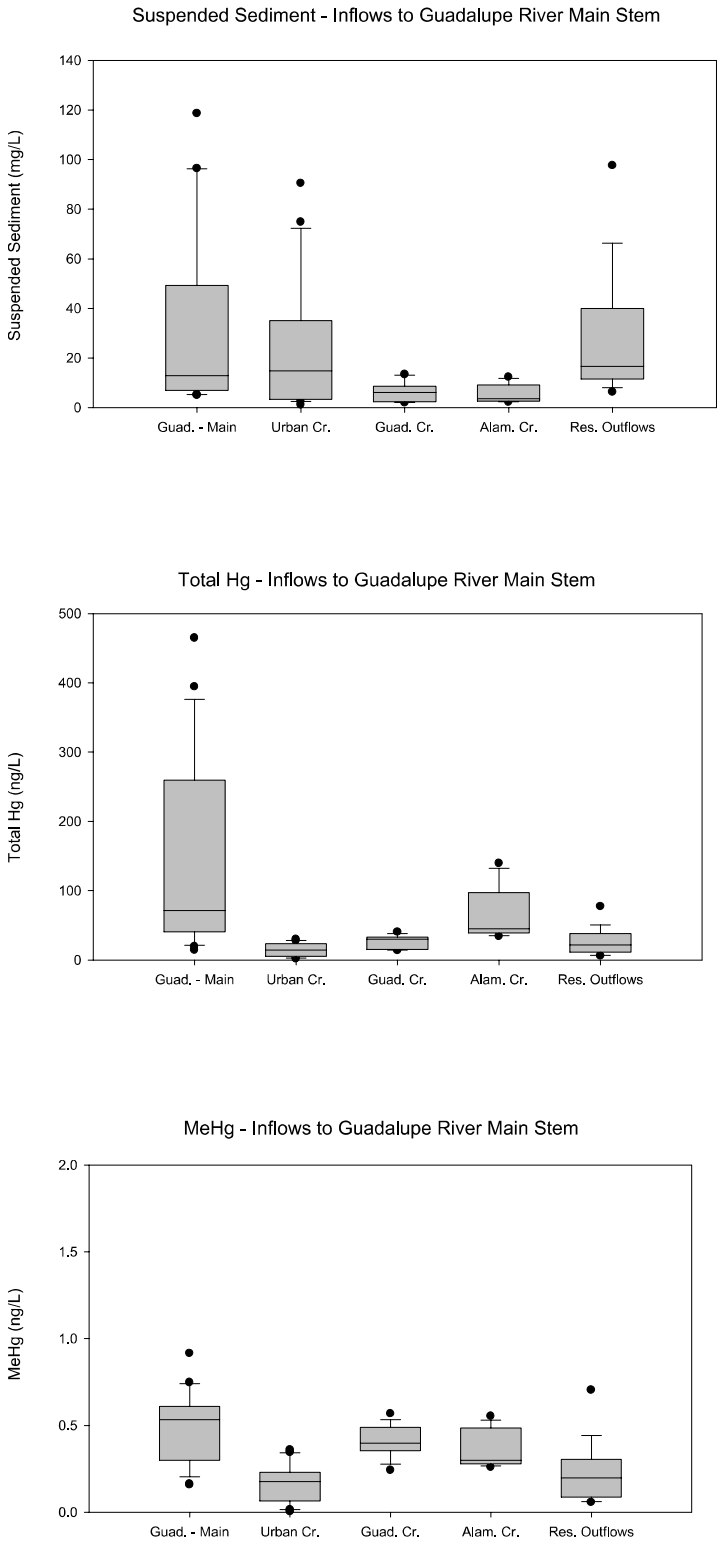
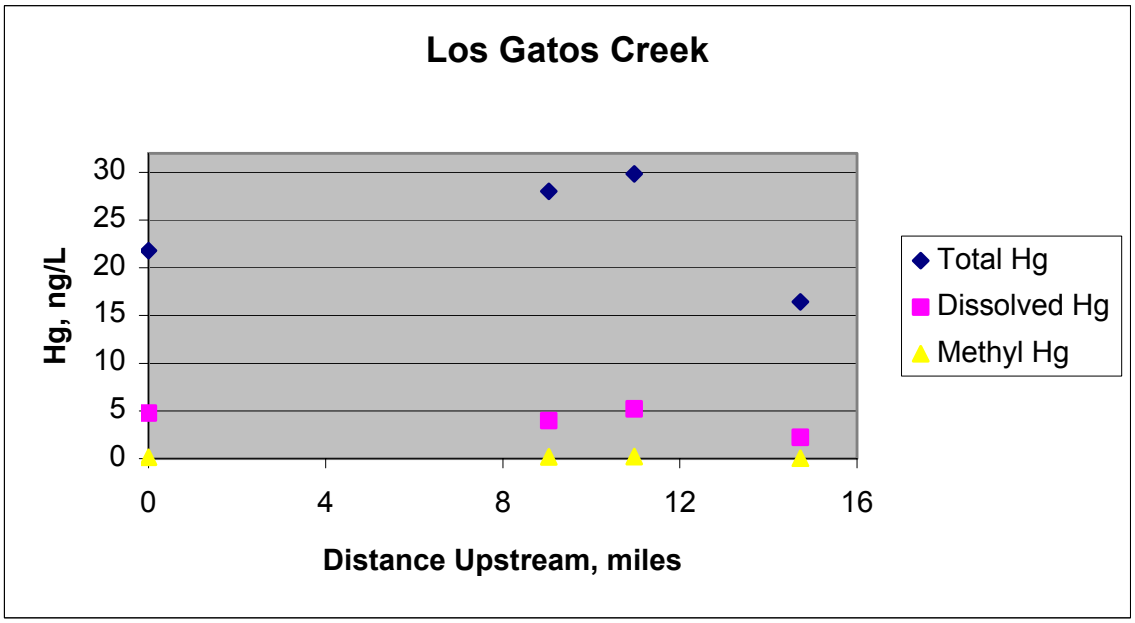
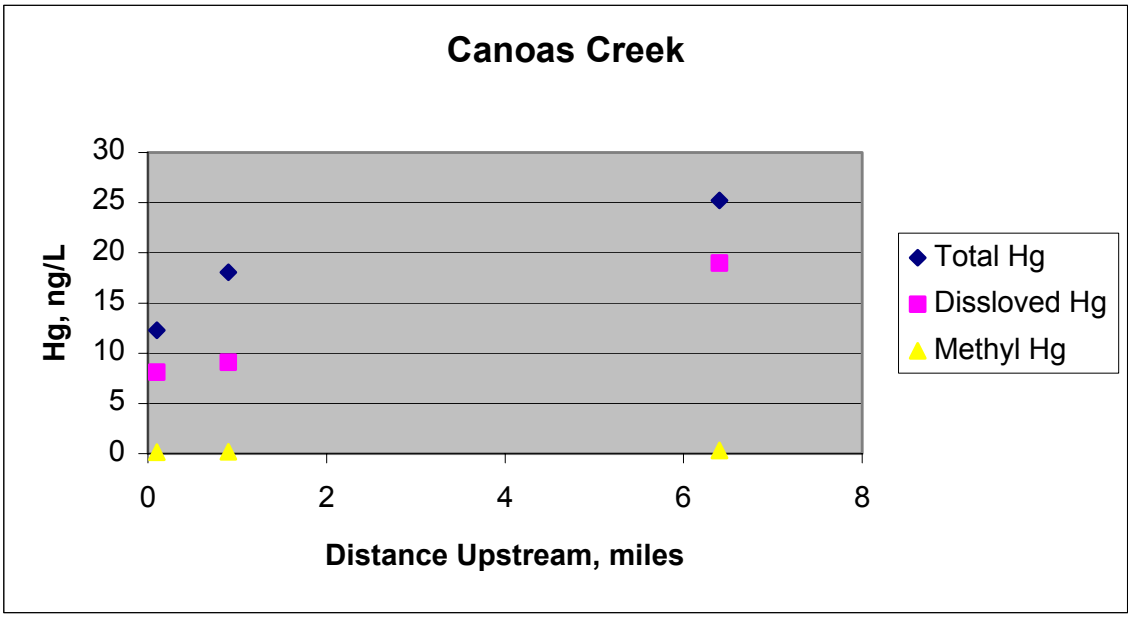


Figure 5-4. Box Plots Comparing Suspended Sediment, Total and Methylmercury for Urban Creeks and Upstream Tributaries to Guadalupe River.





Ross Creek
HgT 18.47 ng/L
HgDis Hg 6.09 ng/L
MeHg 0.23 ng/L

Figure 5-5. Comparison of Mercury Species in Urban Creeks in February 2004

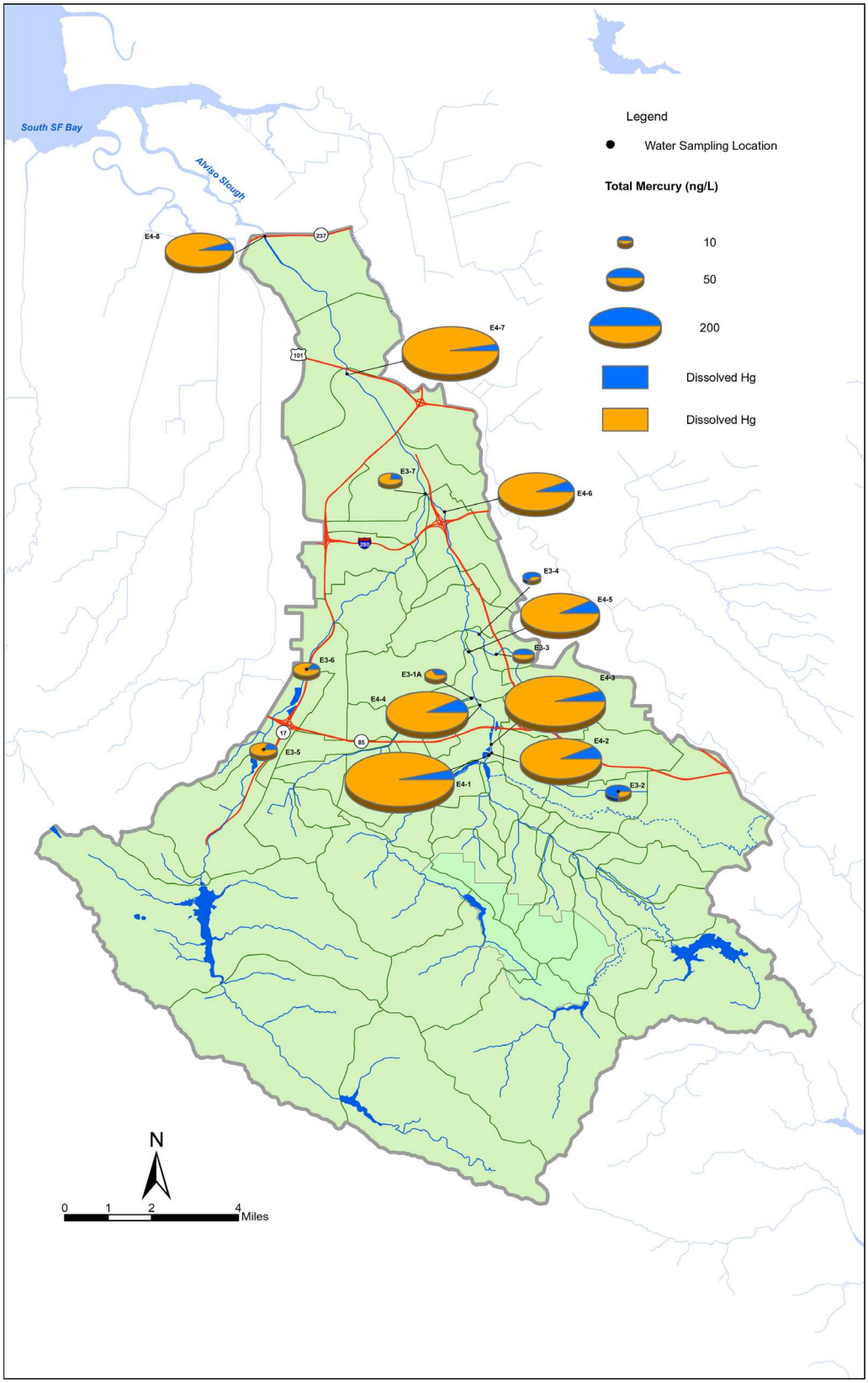


Figure 5-6. Total and Dissolved Mercury for Large Storm Event February 26-27, 2004.

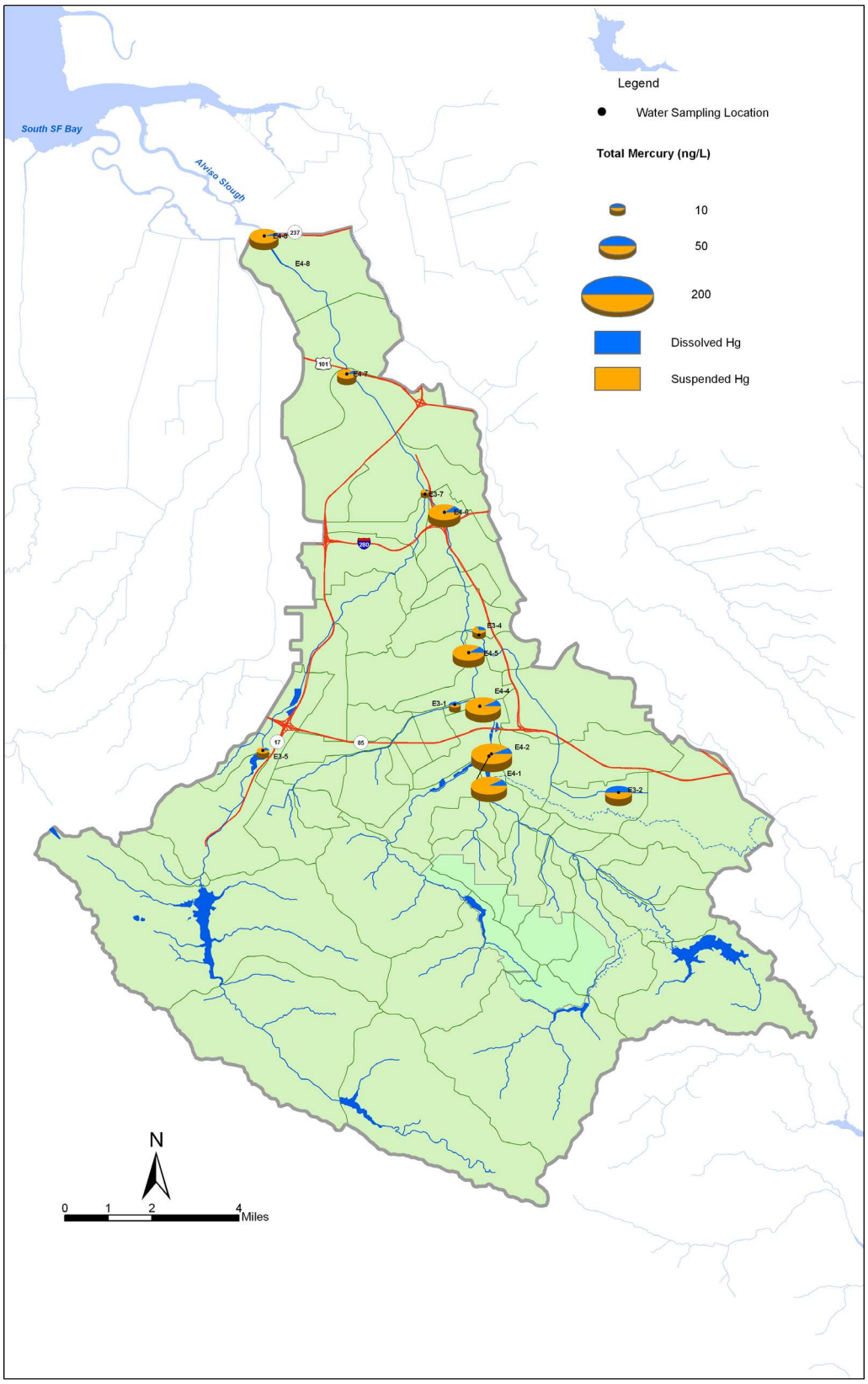


Figure 5-7. Total and Dissolved Mercury for Small Storms – April 2004.

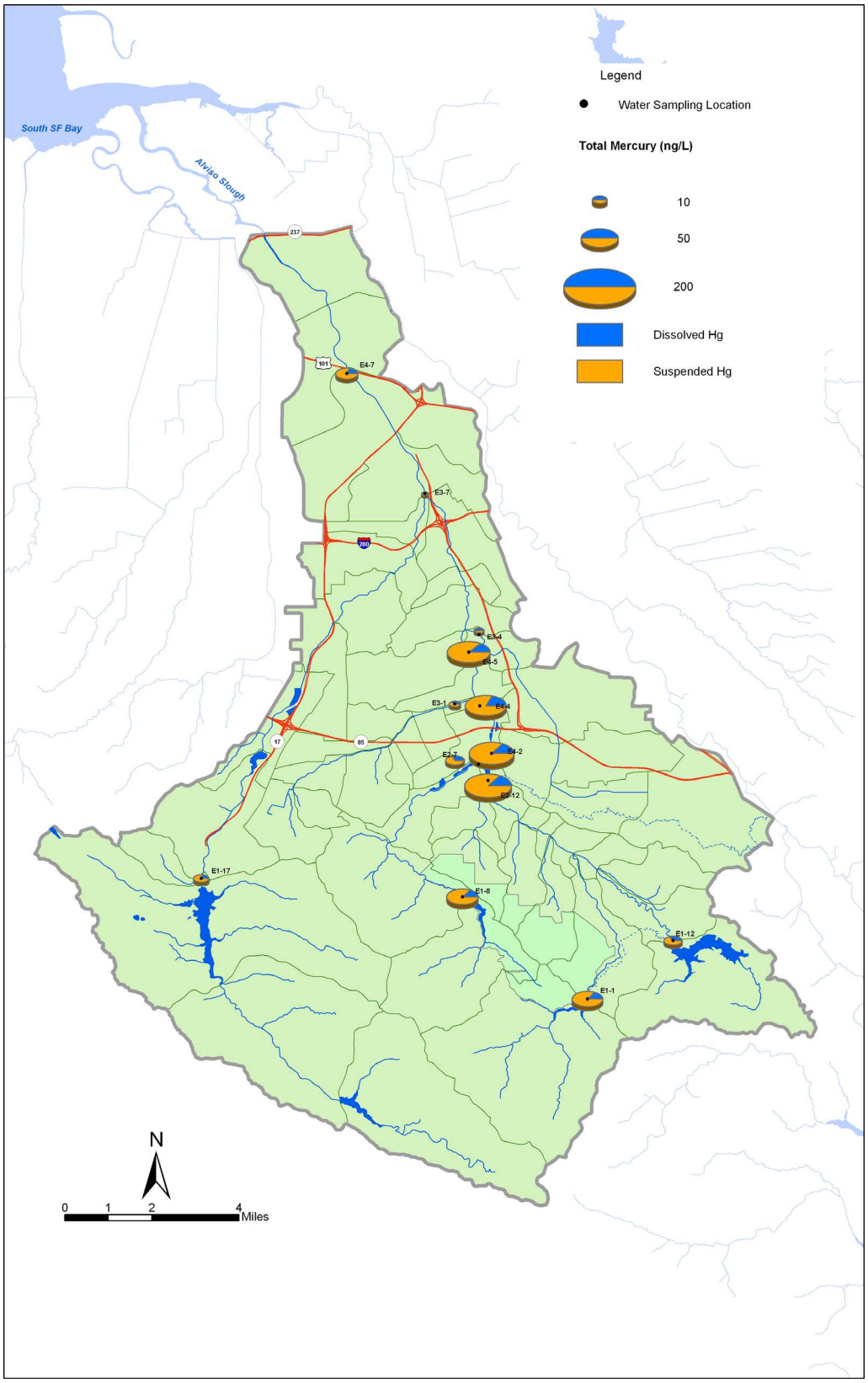
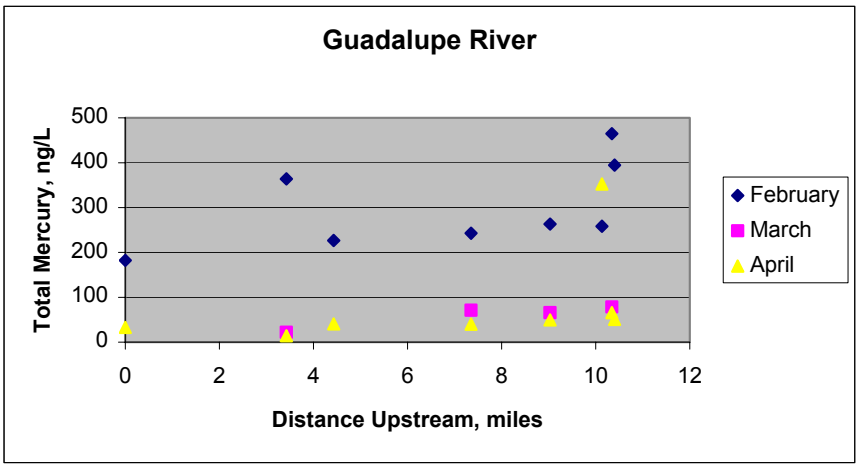
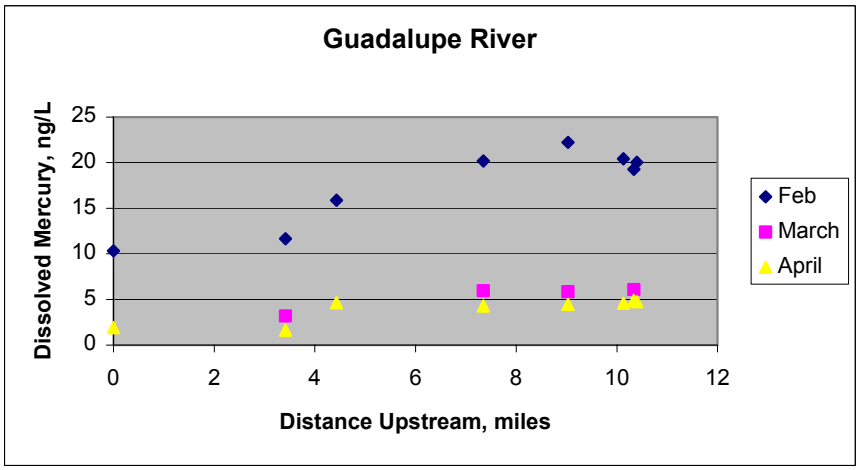
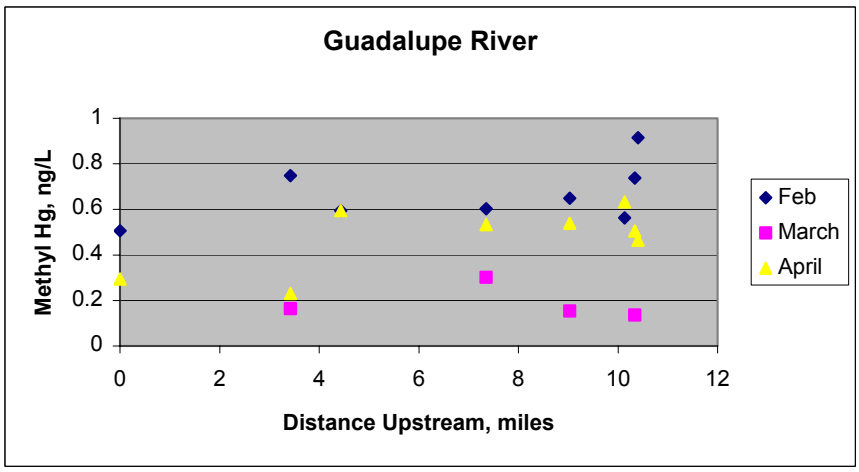


Figure 5-8. Total and Dissolved Mercury for Non-storm Day March 8, 2004







Guadalupe River Flows
Feb 26, 2004 807 cfs
March 8, 2004 29 cfs
April 20, 2004 45 cfs

Figure 5-9. Comparison of Mercury Species along Guadalupe River



Figure 5-10. Sediment Build-up at the Alamaitos Drop Structure (1/27/04) a) above structure and b) sediment pile below structure.

Total and dissolved mercury concentrations were similar in the two low flow events, while methylmercury exhibited more variability. The methylmercury in the three urban creeks ranged from 0.004 to 0.23 ng/L, compared to the river locations that ranged from 0.16 to 0.9 ng/L. The higher methylmercury in the river samples is thought to be due to resuspension of sediment from the river bottom, which would account for the continued high concentrations from the drop structure to San Carlos Street and the increase at Highway 101 on the high flow day. On the low flow events, methylmercury concentrations decreased at both Highway 101 and 237. Most of the methylmercury was associated with the particulate phase, rather than the dissolved phase. Methylmercury is present in the river bottom sediment at concentrations of 0.5 to 1 ng/g in the lower river between Highway 101 and 237.

The measured concentrations of total and methylmercury and suspended solids are compared for the urban creeks, creeks affected by mining, and the reservoir outlets in Figure 5-11. The peak total mercury and methylmercury concentrations were higher in the Guadalupe main stem. These plots show that the urban creeks contribute more suspended solids, but less total and methyl mercury than the two creeks affected by mining. The reservoir outlets had higher methylmercury concentrations in some, but not all the outlets, compared to the urban creeks. The peak methylmercury concentration of 0.9 ng/L was measured in the sample above the Alamitos Drop Structure; the second highest concentration was from Highway 101 for the high flow event (February 26, 2004). These results suggest that resuspension of sediment in the river is an important source for both total and methylmercury.

5.3 Assessment of Data Quality and Constraints

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004a and 2003e) were followed. The QA/QC results for mercury analyses showed that the desired detection limits were achieved, as verified with method blank analyses. The resulting method detection limits (MDLs) in water were 0.2 ng/L for total mercury and 0.018 ng/L for methylmercury. The QA/QC results are discussed in Appendix B, since the data pertain to multiple elements. The water data are usable for data analyses based on the QA/QC criteria.

A high flow event was conducted for Sampling Elements 3 and 4, so a wider range of flows was included than occurred for the other elements. Key locations for both Elements 3 and 4 were sampled on the same non-storm day (March 8, 2004). All but one station for the second storm event were also sampled on the same day in April. Ross Creek was sampled at an upstream location on a different day, because the station at the confluence with the river was dry and a new location needed to be determined. On the day it was sampled, a few days later, flow to the river was blocked by a small drop structure that blocks flows less than about 0.5 cfs. The reservoir outlets and locations at the mouth of Guadalupe and Alamitos Creeks were sampled on all but the high flow day, so comparisons between the outlets and river can be made.

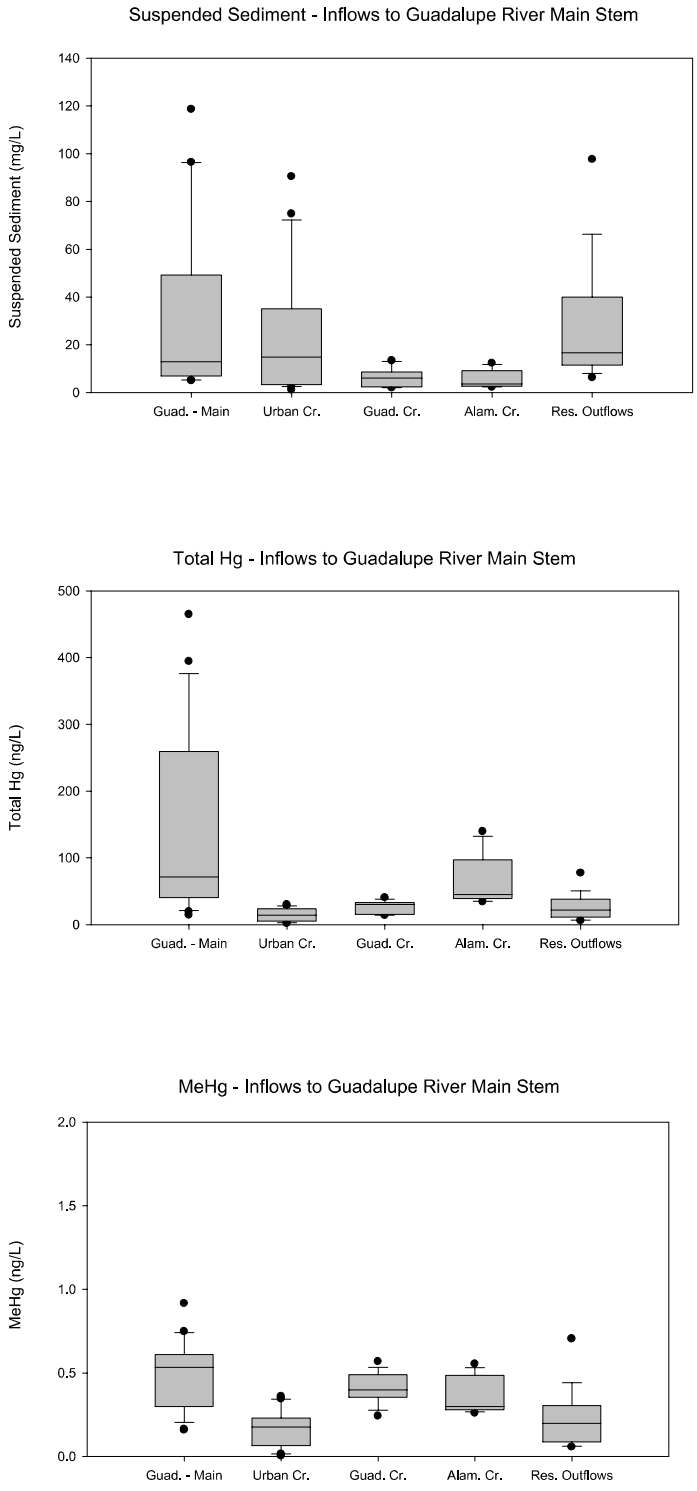


Figure 5-11. Box Plots Comparing Suspended Sediment Total and Methyl Mercury for Guadalupe River Main Stem to Inputs.

5.4 COMPARISON WITH PREVIOUS WATER DATA

Previous sampling results for locations on the Guadalupe River by the USGS, SFEI, Army Corps of Engineers, and the 2003 Synoptic Survey are compared to the new 2004 results.

USGS Survey. Several locations along the Guadalupe River system were sampled in October 2000 by the USGS under dry and wet conditions (Thomas, et al, 2002), as shown in Table 5-6. When Los Gatos Creek above its confluence was sampled by the USGS; the total mercury was 3 ng/L for the dry conditions and 28.5 ng/L for the wet conditions. The total mercury was similar to the new results at the same location (2.0 to 21.8 ng/L). Dissolved mercury increased from 1.3 ng/L under dry conditions to 3.2 ng/L under wet conditions in the 2000 samples, compared to 0.6 to 4.8 ng/L in the 2004 samples. Thus for this creek, the wet weather samples had higher total mercury.

The total mercury concentration in the Guadalupe River at the USGS gauging station was 26 ng/L for a flow rate of 14 cfs and 18 to 139 ng/L when flows varied from 23.9 cfs to 147.5 cfs. The total mercury in the new samples from Highway 101, downstream from the old gauge location, increased at the higher flow conditions of 807 cfs to 364 ng/L. Total concentrations were similar when flows were lower (29 to 45 cfs), ranging from 14.5 ng/L to 22.1 ng/L. The samples at the other common locations showed a similar pattern in that when the flow was higher, mercury concentrations increased.

SFEI. Large storms result in much higher flows at the USGS gauge station greater than 1,000 cfs. Mercury samples for these large storms was analyzed for SFEI. The total mercury concentrations ranged from 0.18 to 18.67 µg/L between November 7, 2002 and May 29, 2003 for 27 samples (McKee et. al., 2004). The maximum mercury concentration occurred in December 16, 2002 when the flow at the old USGS gauge was about 4,500 cfs and the suspended solids were high (967 mg/L). The total mercury concentration at the gauge was 4.96 µg/L on May 29, 2003 when the flow was less than 100 cfs and suspended solids was18.1 mg/L. These results are much higher than the results from the 2004 results, the USGS study discussed above by Thomas, and recent sampling by the Army Corps of Engineers (ACOE, 2004). The higher mercury concentrations for extreme flood conditions are expected, but the measured mercury concentrations were also higher for low flow conditions.

Army Corps of Engineers. The ACOE study collected samples from Guadalupe Creek and Guadalupe River in August and December 2003. The total mercury concentration near the Highway 101 gauge, called Reach A in the report, was 19.8 ng/L for August 4, 2003 and 33.9 ng/L on December 17, 2003. Methylmercury was 0.16 ng/L in August and 0.22 ng/L in December 2003. The August results are similar to the 2004 low flow conditions. The December results had increased total and methylmercury, but were not as high as the results for the high flow event in February 2004. The likely reason is that the suspended solids in the December sample were less (34.5 mg/L), compared to 118.6 mg/L in the February 2004 sample.

Table 5-6
Comparison of Dry and Wet Weather Water Samples for Mercury

	Dry Conditions (October 2000)		Wet Conditions (October 26-27, 2000)	
Sampling Sites	**TSS**	**Total Hg, ng/L**	**TSS**	**Total Hg, ng/L**
Guadalupe River				
above Alviso Slough	163	86	148,167	59, 99
at Orchard Lane	11	19	NA	NA
at USGS Gauging Station	15	26[a]	79,32,35	139, 30,18 [b]
at Almaden Expressway	11	55	31	83
below Guadalupe Reservoir		NA	26	44
Los Gatos Creek	3	3	NA	3, 29

Data are from Thomas et al., 2002. Single-point samples.

[a] Flow was 14 cfs

[b] Flows were 147.5 cfs, 103.4 cfs, 23.9 cfs

Synoptic Survey. Mercury measurements for the Synoptic Survey are compared in Table 5-7 for total mercury and methylmercury. Total mercury was higher for the high flow events at all three locations. The total mercury concentrations in July were similar to those for the non-storm day in March, although the location below the drop structure was about 30 percent higher. Canoas Creek had a different pattern for methylmercury than the other locations, where the summer sample was higher than the wet season events. This creek has more established wetland vegetation in small, shallow pools in the summer, which may produce the anoxic conditions that can lead to methylation.

Table 5-7.
Mercury in Selected Stations the 2003 Synoptic Survey

		Total Mercury, ng/L			
Location		**July-03**	**February-04**	**March-04**	**April-04**
Guad R below ADS	E4-2	105	464.6	78.6	65.7
Canoas Cr mouth	E3-4	3.8	12.3	4.14	7.0
Los Gatos mouth	E3-7	3.2	21.8	2.0	2.9
		Methyl Mercury, ng/L			
Location		**July-03**	**February-04**	**March-04**	**April-04**
Guad R below ADS	E4-2	0.32	0.74	0.309	0.505
Canoas Cr mouth	E3-4	1.35	0.18	0.004	0.153
Los Gatos mouth	E3-7	0.037	0.16	0.017	0.015

6.0 SEDIMENT SAMPLING

The sediment sampling results are presented in this section for all samples from Elements 1, 2, and 5.

6.1 PURPOSE AND DESIGN OF SEDIMENT SAMPLING

Upstream Tributaries

Sampling was conducted to compare total mercury and methyl mercury in sediment from creeks in the mining area and from Alamitos and Guadalupe Creeks to bank soil and bottom sediment from the Guadalupe River. The sediment in the mining area creeks was collected to determine the potential for resuspension and transport of mercury-bearing sediment. The sediment data from the gravel bars at the mouth of Alamitos and Guadalupe Creeks were obtained to help answer the question posed below by the Guadalupe TMDL Work Group.

What is the contribution to loading from in-stream processes including erosion and bed material suspension?

The sediment sampling on Alamitos and Guadalupe Creeks was designed to provide evidence to evaluate the following hypotheses:

1. *Mobilization of sediments during storm events increases total, dissolved, and methyl mercury concentrations in waterways.*

2. *Mercury concentrations associated with mobilization of sediments decreases with distance from the mined areas.*

Sampling Design: Sampling was conducted as one event at each location. Descriptions of the sampling locations and the rationale for their selection are presented in Table 6-1. The sampling stations are listed in Table 6-2 with the geographic coordinates; and are shown on the map (Figure 6-1). The mining area bottom sediment samples were collected from the Mine Hill tributary to Jacques

Table 6-1.
Description of Sediment Sampling Stations and Rationale for Sediment Samples in Guadalupe River and Upstream

Element	Sampling Site Identifier	Sampling Station Description	Rationale
5 Hg in Guadalupe River Sediment	E5-1	Guadalupe River above Alamitos Drop Structure	Measure Hg in sediment and see if differs from that below drop structure and ponds. Compare Hg by grain size and Hg bioavailability using sequential extractions.
	E5-2	Guadalupe River below Alamitos Drop Structure	
	E5-3	Guadalupe River at Blossom Hill Road	
	E5-4	Guadalupe River at Highway 101	Measure Hg in sediment, compare Hg by grain size, and Hg bioavailability using sequential extractions. Compare Hg near SF Bay to other samples from watershed collected under elements 1 and 2.
	E5-5	Guadalupe River at Highway 237	
1	E1-7S	Mine Hill tributary to Jacques Gulch	Measure Hg concentrations in creek sediment draining area with mine waste in Almaden Reservoir watershed. Collect sediment sample for total Hg, Hg by grain size and Hg bioavailability.
1	E1-9S	N. Los Capitancillos Creek	Measure Hg concentrations in creek draining area affected by mining in Guadalupe Reservoir watershed. Samples for total Hg on two previous dates show that Hg concentrations were less than for other mine area samples; but Hg was present. MeHg has not been sampled. Collect sediment sample for total Hg, Hg by grain size and Hg bioavailability.
2	E2-13-SA	Gravel Bar on Alamitos Creek confluence with Almaden Lake	Measure Hg in sediment. Compare Hg by grain size and Hg bioavailability using sequential extractions.
2	E2-13-SG	Gravel Bar where Guadalupe Creek meets Alamitos Creek	Measure Hg in sediment and see if influenced by mine waste. Compare Hg by grain size and Hg bioavailability using sequential extractions.
2	E2-19S	Sediment-debris dam on McAbee Creek below mining area	Measure Hg in sediment and see if influenced by mine waste.

Methylmercury and percent methylmercury were measured in all above samples, except E2-19S.

Table 6-2.
Sediment Sampling Locations

Station ID*	Station Name	Date	Time	Latitude	Longitude
E1-7S	Mine Hill Tributary to Jacques Gulch	3/2/2004	3:30 PM	37° 09.844'	121° 50.799'
E1-9SA	N. Los Capitancillos Creek	3/3/2004	9:55 AM	37° 11.119'	121° 52.247'
E1-9SB	N. Los Capitancillos Creek (replicate)	3/3/2004	9:55 AM	37° 11.119'	121° 52.247'
E2-13SA	Gravel bar on Alamitos Ck. Above Almaden Lake	3/3/2004	12:34 PM	37° 14.313'	121° 52.265'
E2-13SG	Gravel bar where Guadalupe Ck. Meets Alamitos Ck.	3/3/2004	1:15 PM	37° 14.660'	121° 52.357'
E2-19S (Bottom/Bank)	McAbee Creek below Senador Mine entrance to ACQP	4/23/2004	12:20 PM	37° 12.902'	121° 52.900'
E5-1	Guadalupe River above Almaden Drop Structure	3/8/2004	10:15 AM	37° 14.821'	121° 52.220'
E5-2 (Bottom/Bank)	Guadalupe River below Almaden Drop Structure	3/8/2004	11:30 AM	37° 14.838'	121° 52.192'
E5-3 (Bottom/Bank)	Guadalupe River at Blossom Hill Rd.	3/8/2004	11:07 AM	37° 15.016'	121° 52.226'
E5-4A (Bottom/Bank)	Guadalupe River at Highway 101	3/8/2004	3:10 PM	37° 22.401'	121° 55.934'
E5-4B (Bottom/Bank)	Guadalupe River at Highway 101 (replicate)	3/8/2004	3:10 PM	37° 22.401'	121° 55.934'
E5-5 (Bottom/Bank)	Guadalupe River at HWY 237	3/8/2004	1:05 PM	37° 24.651'	121° 57.653'

*Two sediment samples were collected at bottom and bank of the Element 5 locations, except at E5-4 where four samples were collected.

AQCP stands for Alamaden Quicksilver County Park.

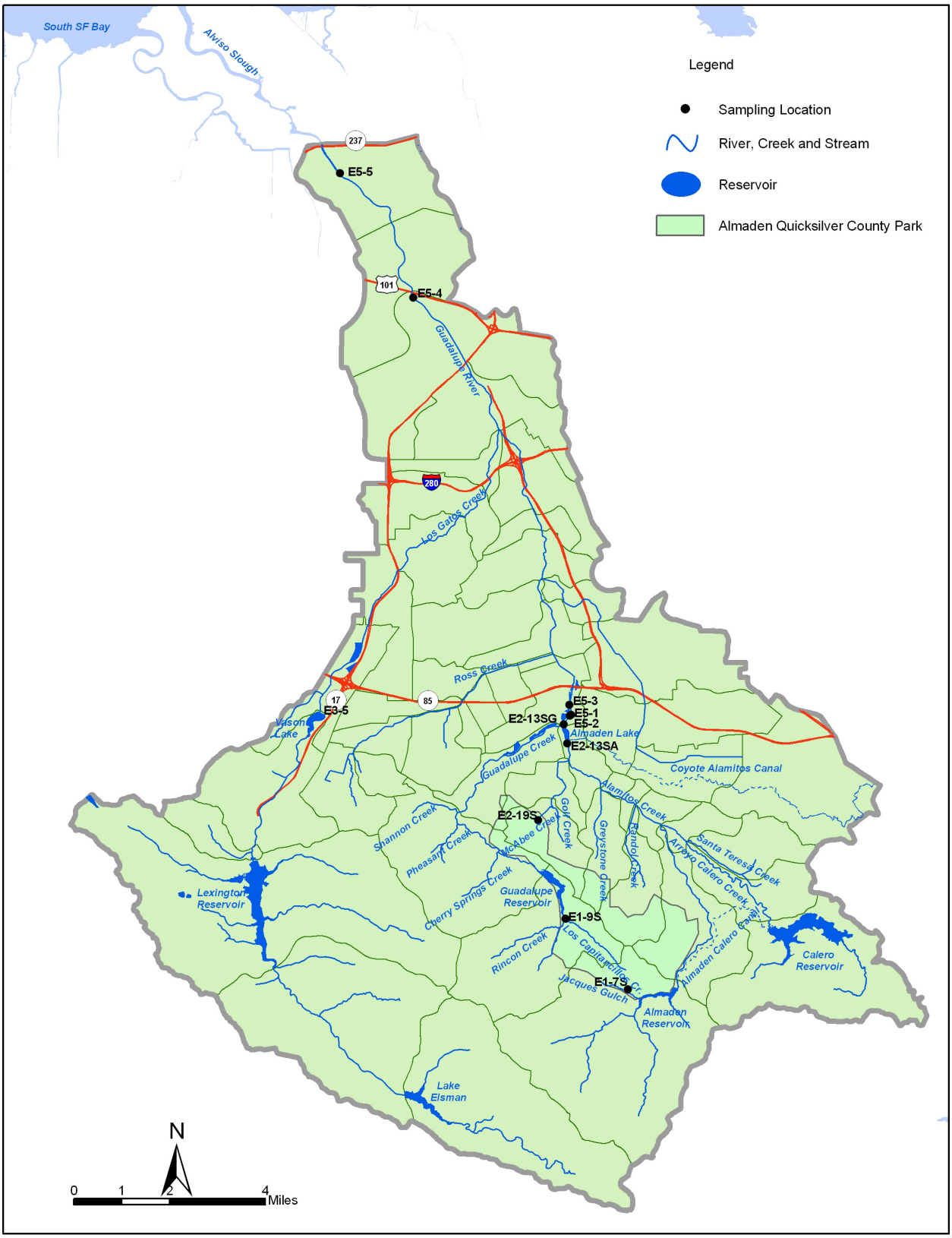


Figure 6-1. Sediment Sampling Locations for Wet Season 2004

Gulch (E1-7S) and N. Los Capitancillos Creek (E1-9S). These samples were analyzed for total and methylmercury, grain size distribution, and moisture. A sampling location on McAbee Creek, a tributary to Golf Creek, was added, since a large debris dam was found in the creek below the Senador Mine entrance to the Almaden Quicksilver County Park (AQCP). Both bottom and bank samples were collected and analyzed for total mercury. This sample is designated as "E2-19S". At the time of the sampling on April 23, 2004, the creek was too shallow to be sampled, so no water sample was collected at this location. A water sample from Golf Creek was collected below the confluence of this tributary and another tributary that flows through a suburban area on the same day as the sediment sample was collected. Bank and bottom samples are distinguished in the data where multiple samples were collected. If a station does not have bank or bottom in the station ID, only a bottom sample was collected.

Sediment samples were also collected from two gravel bars: where Alamitos Creek enters Almaden Lake and at the confluence where Guadalupe Creek meets Alamitos Creek below the lake; these gravel bars are visible in the photograph (Figure 6-2). These samples were analyzed for total and methylmercury, grain size distribution, and moisture.

Use of Data in the TMDL: The results from the tributary sediment sampling have been used to provide:

- Estimates of the relative magnitude of total mercury and methylmercury concentrations in the tributaries sampled.
- Comparisons of mercury in sediment from the mining area to downstream locations.

The results of this sampling element will be used for the TMDL to evaluate the potential for transport of sediment to the Bay.

River Sampling

Sediment samples were collected from the Guadalupe River under Sampling Element 5. The locations sampled along the Guadalupe River and the rationale were provided in Table 6-1 along with the tributary samples; all locations were shown on the map (Figure 6-1).

Sediment transport is an important factor in the release of mercury to San Francisco Bay. Sampling was conducted along the Guadalupe River to address the following question put forward by the Guadalupe Mercury Work Group:



Figure 6-2. Aerial photograph of Lake Almaden and vicinity showing gravel bars at mouths of Guadalupe and Alamitos Creeks

What portion of the sediment load contains mercury and what is the percentage of bioavailable mercury in sediments in Guadalupe River?

Sampling Element 5 addressed two hypotheses:

1. *Mercury concentrations in sediment vary with grain size and distance from the mining areas. Near the mining areas, larger particles contain the highest proportion of mercury. Near the Bay, silts and fines contain the highest proportion of mercury.*

2. *The percentage of the mercury in sediment that is potentially bioavailable varies with grain size and distance from the mining areas.*

Sampling Design: Sediment sampling along the Guadalupe River was conducted on one of the days when water samples were collected for Element 4 (March 8, 2004). At each of four locations along the Guadalupe River, four samples were collected: two bottom sediment samples and two bank samples. At one of these locations (E5-4), an additional set of four samples was collected to provide an estimate of variability. One additional sediment sample was collected from above the Alamitos Drop Structure on the Guadalupe River in the back-up sediment above the wall that forms in the wet season. The sediment samples were analyzed for total mercury, methylmercury, moisture content, and grain size. In addition, samples were collected at three locations (E5-2, E5-4, and E5-5) from the river bottom for analysis of sulfate and sulfide.

Additional analyses were conducted to evaluate relationships between mercury and grain size and the bioavailability of the mercury. A total of 16 sediment samples were sieved into major grain size fractions; total mercury was analyzed in the two major size fractions in each sample. Eleven of the samples were from the Guadalupe River, three from the mining area, and two from the gravel bars formed by Alamitos and Guadalupe Creeks.

A five-step sequential extraction procedure (Bloom, et. al., 2003) was performed in the laboratory to estimate the bioavailability of the mercury in sediment samples from the river and upstream tributaries. The extraction steps are listed below (Bloom et al, 2003):

Step	Extractant	Description	Typical Compounds
F1	Deionized water	water soluble	$HgCl_2$, $HgSO_4$
F2	pH 2 HCl/HOAc	"stomach acid"	HgO
F3	1M KOH	organo complexed	Hg-humics, Hg_2Cl_2
F4	12M HNO3	strong complexed	mineral lattice, Hg_2Cl_2, Hg^o
F5	aqua regia	cinnabar	HgS, m-HgS, HgSe, HgAu
Sum			total Hg

This procedure was conducted on four river bank samples, five river bed sediment samples, and three samples from tributaries in the mining area. A one-step leaching procedure, representing the first three steps of the five-step procedure, was conducted with the F3 leaching solution on three coarse river sediment samples, two river bank samples also used for the 5-step procedure, and a coarse sediment sample from the gravel bar at the mouth of Alamitos Creek.

Use of Data in the TMDL: The sediment results were used to provide:

- Estimates of total and methylmercury concentrations in sediment at key locations in the Guadalupe River and to compare to the upstream tributaries
- Grain size distribution and total mercury concentrations in each size fraction at key locations
- Results of sequential extractions of sediment to evaluate potential bioavailability of mercury.

6.2 SEDIMENT SAMPLE RESULTS

The total mercury and methylmercury concentrations and computed percent methylmercury are presented in Table 6-3. The data in this table are shown both on a dry weight and "wet" or as received basis. The concentrations presented on maps, plots, and discussed in the text are presented on a dry weight basis. Notable findings from the sediment samples are:

- **Mercury.** The total mercury concentrations in the sediment samples(dry-wt basis) are summarized below:
    - mercury in sediment from creeks in the mining area ranged from 180 to 18,655 ng/g.
    - mercury in sediment in the two gravel bars at the end of Alamitos and Guadalupe Creeks ranged from 16,450 to 18,775 ng/g.
    - mercury in sediment from the Guadalupe River ranged from 64.8 ng/g to 39,279 ng/g.

- **Methylmercury**. The methylmercury concentrations in the sediment samples are summarized below:
    - 0.05 to 0.14 ng/g in sediment from creeks in the mining area;
    - 0.06 to 0.29 ng/g in sediment from the two gravel bars at the end of Alamitos and Guadalupe Creeks;
    - 0.05 ng/g to 3.2 ng/g in sediment from the Guadalupe River.

Sulfate and Sulfide. Sulfate concentrations ranged from 100 to 450 mg/kg dry (Table 6-4). Sulfide was detected in all samples, and ranged from 56.9 to 539 mg/kg. The two bottom sediment samples from Highway 101 had lower sulfide concentrations than those above and below the Alamitos Drop Structure, which is consistent with the fine-grained material in the lower reaches of the river. The sulfate concentrations in the Highway 101 samples varied. There was no sulfide in the water from either of

Table 6-3.
Mercury Speciation in Sediments from Guadalupe River and Selected Tributaries

Station ID	Station Name	Date Sampled	dry fraction	Results on as received basis		Results on dry basis		Percent Methyl Hg
				Total Hg ng/g	Methyl Hg ng/g	Total Hg ng/g	Methyl Hg ng/g	
E1-7S	Mine Hill Tributary to Jacques Gulch	3/2/2000	0.726	4,797	0.104	6,607	0.143	0.0022
E1-9SA	N Los Capitancillos Creek	3/3/2000	0.719	848	0.040	1,179	0.056	0.0047
E1-9SB	N Los Capitancillos Creek (rep)	3/3/2000	0.750	135	0.040	180	0.053	0.0296
E2-13 SA	Alamitos Creek above Almaden Lake	3/3/2000	0.898	14,772	0.058	16,450	0.065	0.0004
E2-13 SG	Guadalupe Creek above confluence	3/3/2000	0.895	16,804	0.266	18,775	0.297	0.0016
E5-1 bottom	Guadalupe River above Alamitos DS	3/8/2000	0.667	7,551	1.596	11,321	2.393	0.0211
E5-2 bank A	Guadalupe River below Alamitos DS	3/8/2000	0.857	21,593	1.492	25,196	1.741	0.0069
E5-2 bank B	Guadalupe River below Alamitos DS	3/8/2000	0.824	15,745	1.561	19,108	1.894	0.0099
E5-2 bottom A	Guadalupe River below Alamitos DS	3/8/2000	0.692	27,181	1.467	39,279	2.120	0.0054
E5-2 bottom B	Guadalupe River below Alamitos DS	3/8/2000	0.683	5,921	2.209	8,669	3.234	0.0373
E5-3 bank A	Guadalupe River at Blossom Hill Road	3/8/2000	0.899	2,843	0.436	3,162	0.485	0.0153
E5-3 bank B	Guadalupe River at Blossom Hill Road	3/8/2000	0.841	4,688	1.331	5,574	1.583	0.0284
E5-3 bottom A	Guadalupe River at Blossom Hill Road	3/8/2000	0.788	51.1	0.037	64.8	0.047	0.0724
E5-3 bottom B	Guadalupe River at Blossom Hill Road	3/8/2000	0.725	88.5	0.031	122	0.043	0.0350
E5-4 Bank A	Guadalupe River at Highway 101	3/8/2000	0.819	2,419	1.677	2,954	2.048	0.0693
E5-4 bank B	Guadalupe River at Highway 101	3/8/2000	0.881	2,313	1.809	2,625	2.053	0.0782
E5-4 bank C	Guadalupe River at Highway 101 (rep)	3/8/2000	0.812	2,712	1.856	3,340	2.286	0.0684
E5-4 bank D	Guadalupe River at Highway 101 (rep)	3/8/2000	0.838	2,308	1.687	2,754	2.013	0.0731
E5-4 bottom A	Guadalupe River at Highway 101	3/8/2000	0.722	2,025	0.329	2,805	0.456	0.0162

Table 6-3. (continued)
Mercury Speciation in Sediments from Guadalupe River and Selected Tributaries

Station ID	Station Name	Date Sampled	dry fraction	Results on as received basis		Results on dry basis		Percent Methyl Hg
				Total Hg ng/g	Methyl Hg ng/g	Total Hg ng/g	Methyl Hg ng/g	
E5-4 bottom B	Guadalupe River at Highway 101	3/8/2000	0.735	216	0.465	293	0.633	0.2158
E5-4 bottom C	Guadalupe River at Highway 101 (rep)	3/8/2000	0.720	269	1.423	374	1.976	0.5290
E5-4 bottom D	Guadalupe River at Highway 101 (rep)	3/8/2000	0.756	312	0.520	413	0.688	0.1666
E5-5 bank A	Guadalupe River at Highway 237	3/8/2000	0.571	380	0.581	665	1.018	0.1531
E5-5 bank B	Guadalupe River at Highway 237	3/8/2000	0.615	363	0.536	590	0.872	0.1476
E5-5 bottom A	Guadalupe River at Highway 237	3/8/2000	0.673	227	0.142	337	0.211	0.0626
E5-5 bottom B	Guadalupe River at Highway 237	3/8/2000	0.643	497	0.546	772	0.849	0.1099
E2-19S Bottom	McAbee Creek below Senador Mine entrance to AQCP	4/23/2000	0.532	NA	NA	9,398	NA	NA
E2-19S Bank	McAbee Creek below Senador Mine entrance to AQCP	4/23/2000	0.834	NA	NA	18,655	NA	NA

Sediment samples were analyzed by Frontier Geosciences Aquatic Research Group using the following procedure:

total Hg by aqua regia digestion + $SnCl_2$ reduction, dual amalgamation CVAFS; CH_3Hg by HBr/CH_2Cl_2 extraction + aqueous ethylation + GC-CVAFS.

AQCP stands for Alamaden Quicksilver County Park.

Table 6-4.
Sulfate and Sulfide Concentrations in Sediment Samples

Station ID	Station Name	Date Sampled	Sulfide, mg/kg	Sulfate, mg/kg
E5-1	Guadalupe River above Alamitos Drop Structure	3/8/2004	214	350
E5-2	Guadalupe River below Alamitos Drop Structure	3/8/2004	539	140
E5-4A	Guadalupe River at Highway 101	3/8/2004	71.6	450
E5-4B	Guadalupe River at Highway 101 (replicate)	3/8/2004	56.9	100

these locations. The observed sulfate concentrations are enough to support sulfate reduction; sulfate-reducing bacteria are the primary bacteria capable of methylating mercury.

The total mercury and methylmercury concentrations are compared for bank and bottom samples by group in Figure 6-3. The lower river samples were from Highways 101 and 237, while the upper river samples were from Blossom Hill Road to the Alamitos Drop Structure. The tributaries are those in the mining area. For most sediment samples, the total mercury concentrations were higher in the bank sediments than the bottom sediments. This pattern differs for methylmercury concentrations in the upper reaches of the river where the bottom samples had higher concentrations than the bank samples due to the high concentrations below the drop structure. While the sediment data are variable, the general trend of the bottom samples is that total mercury was highest below the drop structure, then low at Blossom Hill Road, higher at Highway 101, then decreasing at Highway 237 (Figure 6-4). The importance of the higher mercury in the bank samples is that during high flow events, erosion or sloughing of the bank soils can occur, which introduces higher mercury-bearing sediment to the river.

Of the tributary sediment samples, the highest total mercury concentration was in the sample from the Guadalupe Creek gravel bar (18,775 ng/g), although the sample from the channel bank on McAbee Creek was almost as high (18,655 ng/g). The gravel bar sample from Alamitos Creek was the third highest tributary sample (16,450 ng/g). The high concentrations at all these locations are due to previous transport downstream from mining areas. Both sediment samples from the upstream mining area had lower concentrations: 6,607 ng/g from the Mine Hill tributary to Jacques Gulch and 1,179 to 180 ng/g in two replicate sediment samples from N. Los Capitancillos Creek. The data show that the mercury concentrations can be high due to past transport of mine wastes, such as downstream at the mouth of these two creeks and below the Alamitos drop structure. The two bottom sediment samples below the drop structure also had elevated mercury (8,669 and 39,279 ng/g).

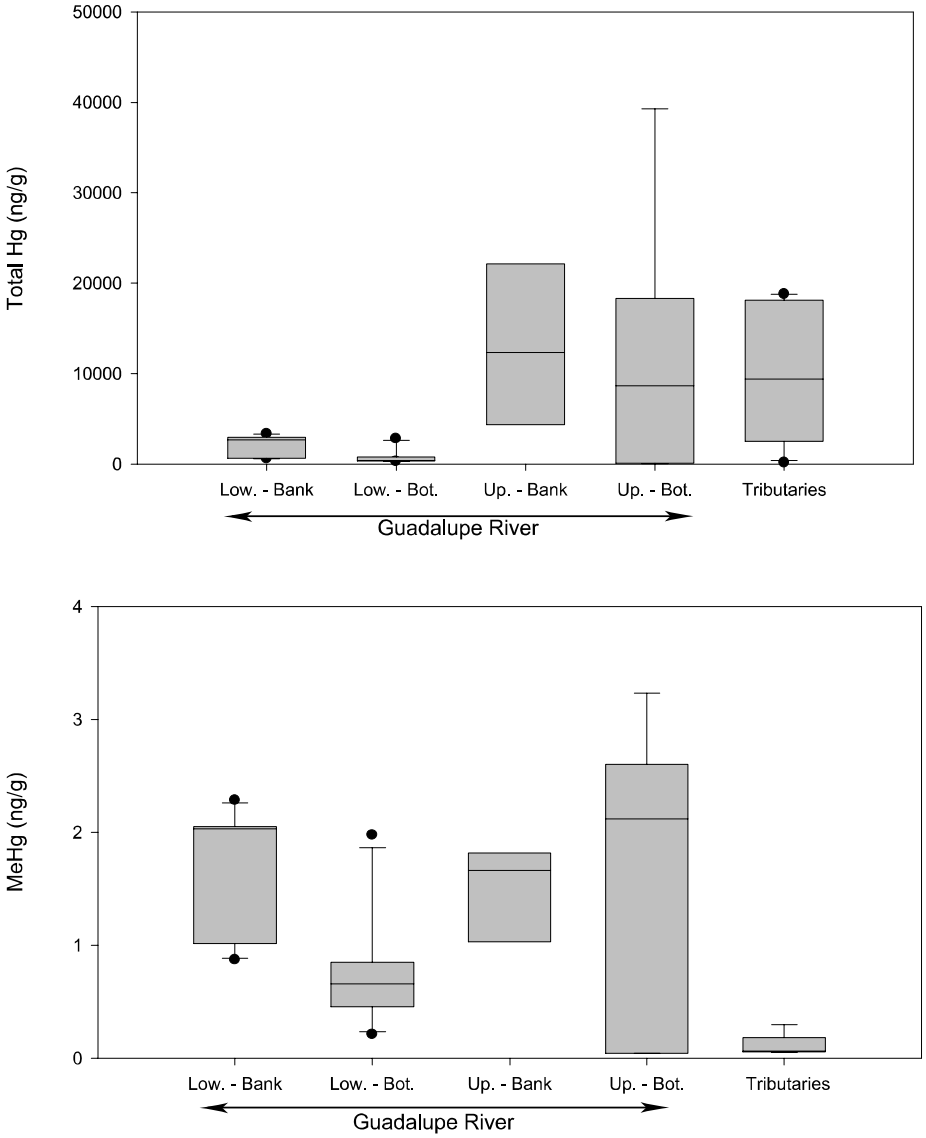
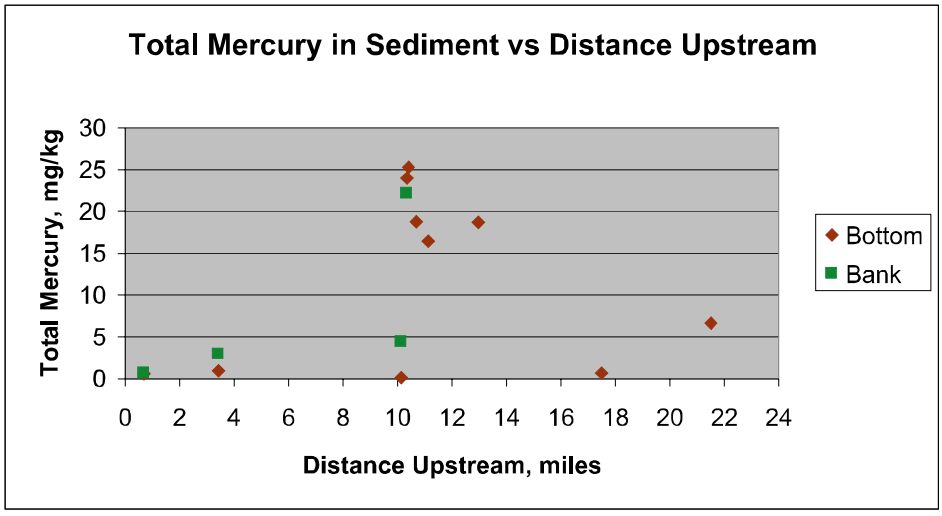
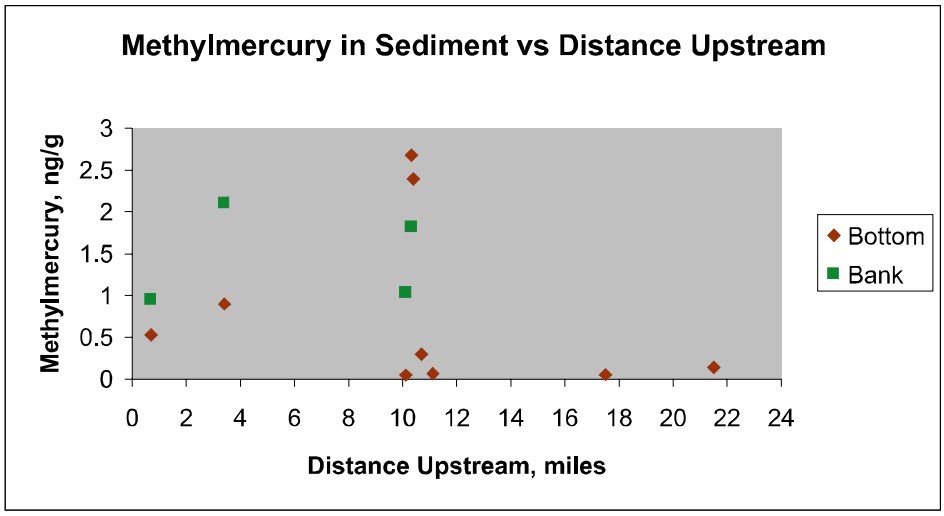


Figure 6-3. Box Plots Comparing Bank and Bottom Samples along the Guadalupe River to the Tributaries





Sediment Sampling Sites

Mile	Station	Location
0.7	E5-5	Guadalupe River at Highway 237
3.42	E5-4	Guadalupe River at Highway 101
10.13	E5-3	Guadalupe River at Blossom Hill Rd.
10.34	E5-2	Guadalupe River below Almaden Drop Structure
10.4	E5-1	Guadalupe River above Almaden Drop Structure
10.7	E2-13SG	Guadalupe Creek at mouth
11.12	E2-13SA	Alamitos Creek above Lake
12.96	E2-19S	McAbee Creek below Park Entrance
17.5	E1-9S	N Los Capitancillos Cr to Guadalupe Reservoir
21.5	E1-7S	Mine Hill Tributary to Jacques Gulch

Average concentrations are plotted at each location with multiple samples.

Figure 6-4. Total Mercury and Methylmercury along Guadalupe River

High total and methylmercury were measured near the drop structure. The highest methylmercury (3.2 ng/g) was found in one of the bottom sediment samples below the drop structure, although not the sample with the highest total mercury concentration. The sediment sample in the river at Blossom Hill Road had lower total and methylmercury (Figure 6-5). While the samples from below the drop structure had the highest methylmercury, the percent methylmercury ranged from 0.0054 to 0.037 percent, and was less than the samples from the lower reaches of the Guadalupe River. The highest percent methylmercury was present in the bottom samples from Highway 101 (0.167 to 0.529 percent). The next highest percent methylmercury was in the bank and bottom samples from Highway 237 (0.062 to 0.15 percent). The percent methylmercury in the mining area sediments was less (0.0004 to 0.029 percent). Figure 6-6 shows that there was essentially no relationship between total mercury versus percent methylmercury. Part of the reason may be the difference in type of sediment and grain size, since the lower river sediments are silts and clays, compared to large size gravel and sand in the gravel bar samples and increased sand-size material in the tributary sediment samples (Figure 6-7). Tthe two samples plotted from above and below the drop structure also had finer grain size material than the upstream samples. The percent methylmercury has been used as an indicator of methylation potential, but here the grain size difference may be an important influence apart from *in-situ* methylation.

Additional tests were conducted to evaluate the possible relationships between grain size and mercury. Sixteen samples were clean sieved into a maximum of seven major fractions, although most samples had only two or three size fractions. The percent in each fraction is provided in Table 6-5. The two major size fractions in each sample were analyzed for total mercury. Table 6-6 shows the resulting data, and both the amount of mercury in each fraction compared to the whole sample and the percent of mercury in each size fraction. Notes are included on the size of the fraction not analyzed. The coarser sediment samples from the tributaries had more total mercury in the fraction consisting of >850 μm to 2 mm. In the two gravel bar samples, this comprised most of the mercury in the entire sample. One sample had more total mercury in the >2 mm fraction than the >850 μm to 2 mm fraction. In four of the samples from the lower river reaches, more mercury was found in the smallest fraction analyzed (>5 μm to <50 μm), consistent with weathering of larger particles. There were three bottom samples from Highway 101 (E5-4) and Blossom Hill Road (E5-3) where more mercury was present in coarser fractions.

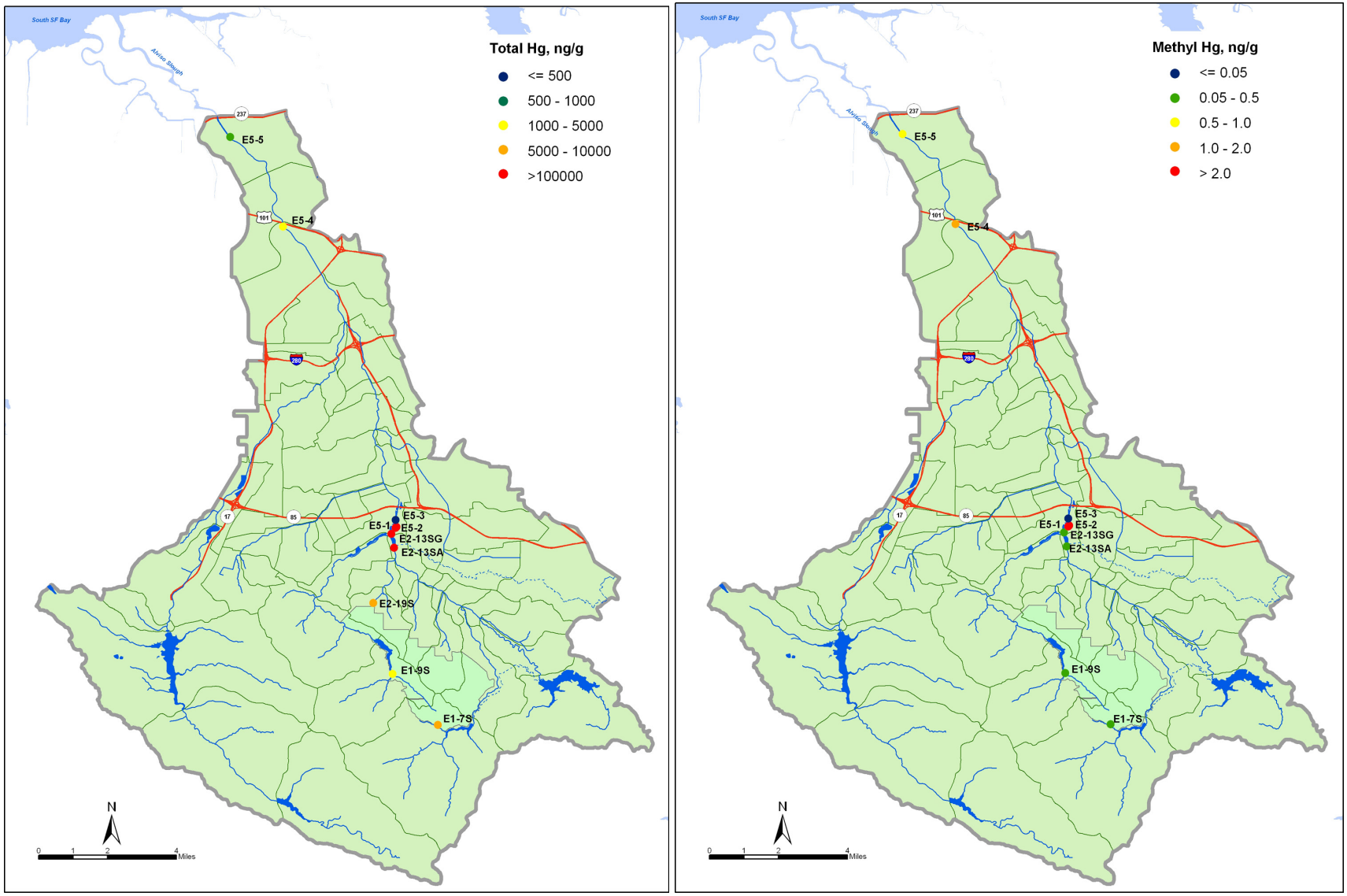


Figure 6-5. Maximum (a total and b) methylmercury concentrations in bottom sediment

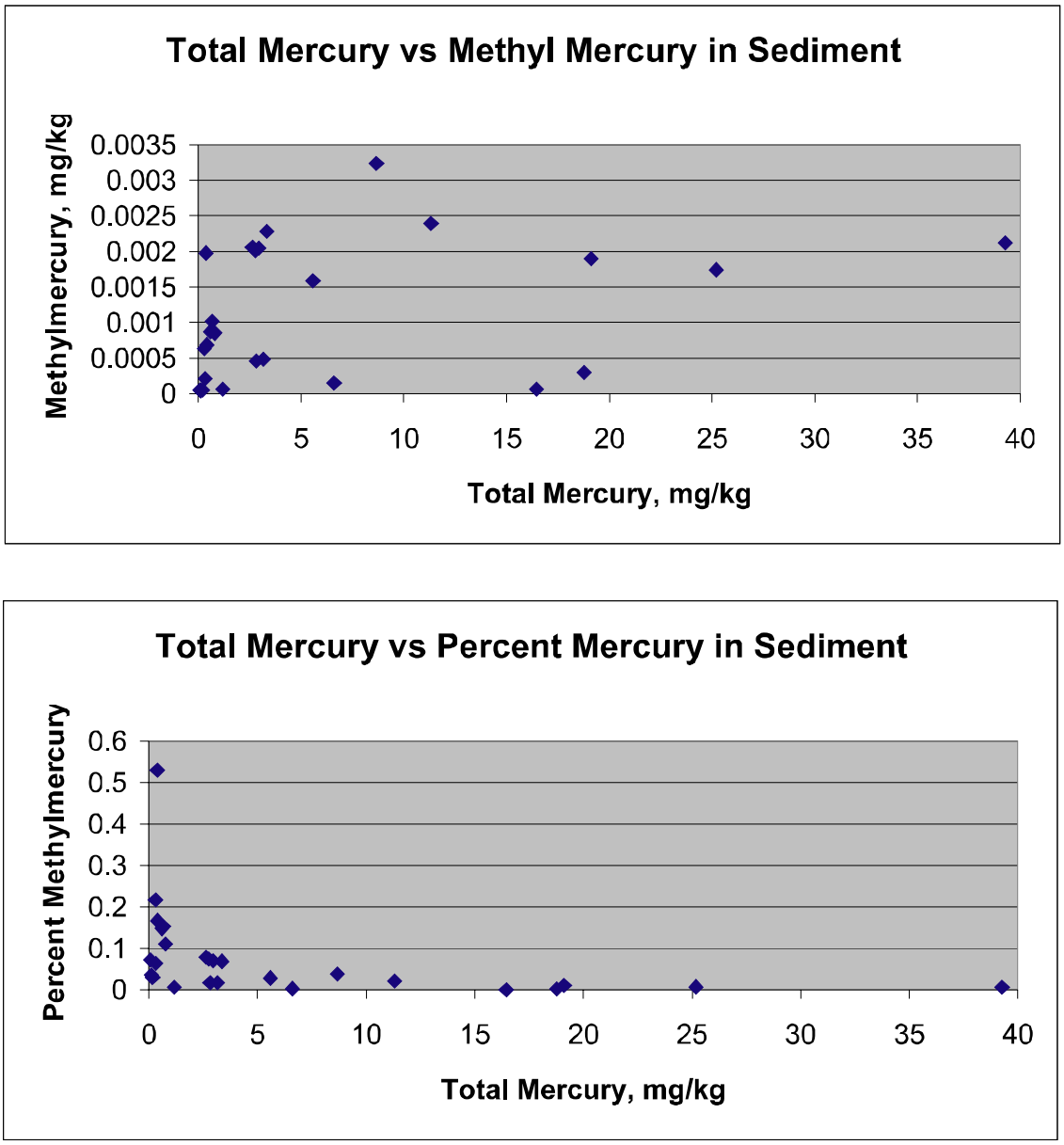


Figure 6-6. Comparison of Total Mercury and methylmercury Concentrations in Sediment Samples (McAbee Creek samples not shown since methylemrcury was not measured.)

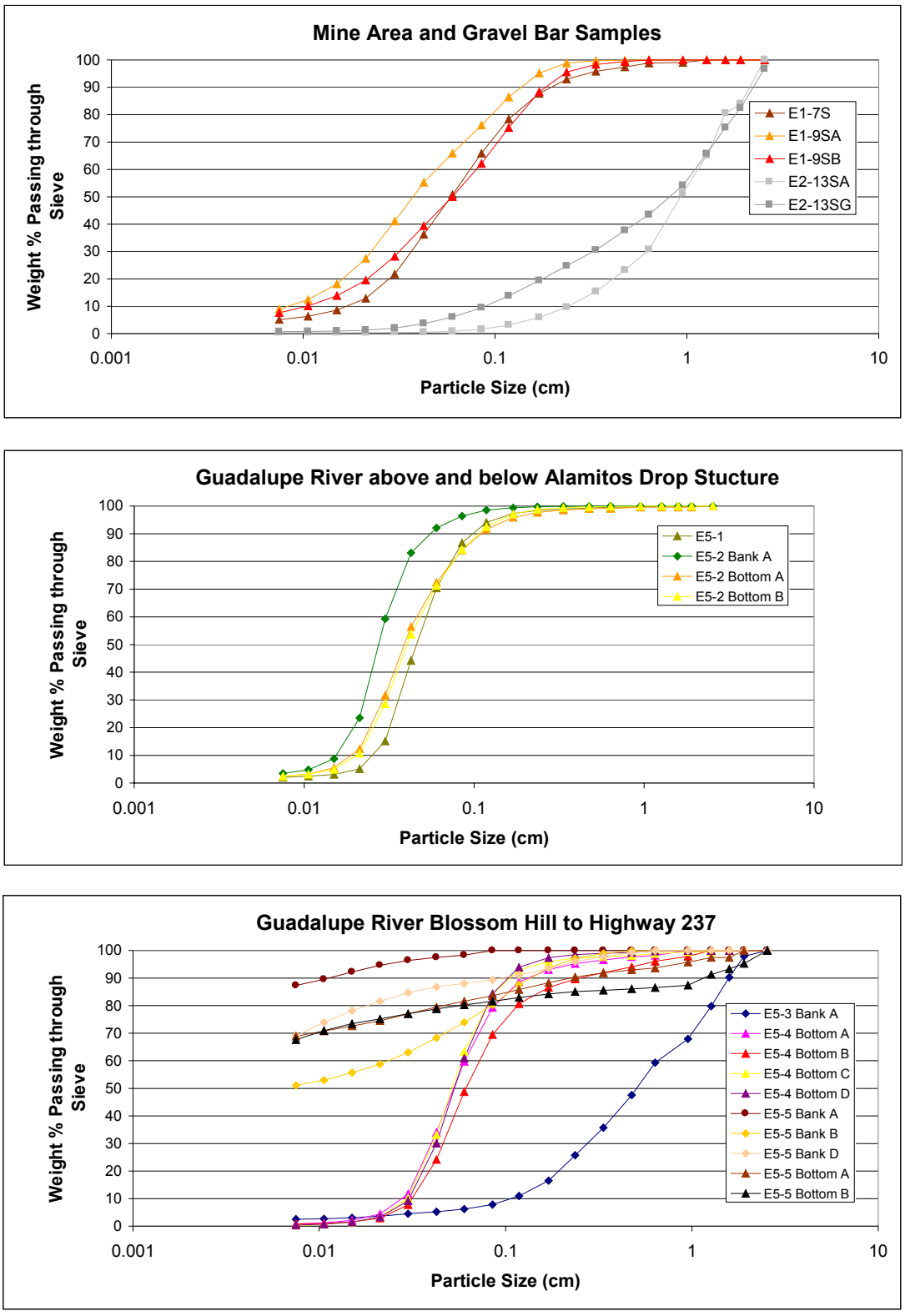


Figure 6-7. Grain Size Distributions for Example Sediment Samples

Table 6-5.
Major Grain Size in Selected Sediments

Particle Size	E5-4 Bottom A 3.8.04	E2-13SA 3.8.04	E5-3 Bottom A 3.8.04	E2-13 SG 3.3.04	E5-3 Bank A 3.8.04	E5-4 Bottom B 3.8.04	E5-2 Bottom A 3.8.04	E5-1 3.8.04	E1-7S 3.2.04	E1-9SB 3.3.04	E1-9SA 3.3.04	E5-2 Bank A 3.8.04	E5-5 Bank A 3.8.04	E5-4 Bank A 3.8.04	E5-5 Bottom A 3.8.04	E5-4 Bank B 3.8.04
>2mm	<1	**85**	**60**	**55**	**50**	<5	10	4	**23**	15	**25**	<1	0	0	0	0
>850um	**25**	**10**	**20**	**30**	**30**	**40**	20	**25**	**22**	**35**	**30**	<5	0	0	0	0
>500um	**60**	<5	8	10	10	**35**	**40**	**23**	20	**30**	20	**25**	<5	0	0	0
>250um	10	<5	5	<5	5	10	**25**	20	20	10	18	**40**	<5	2	5	5
>100um	<5	<5	8	<5	<5	5	<5	12	10	5	5	15	<5	8	5	3
>50um	<5	<5	<5	<5	<5	<5	<5	8	<5	<5	<5	9	**10**	**15**	**20**	**12**
>5um	0	<5	<5	<5	0	5	<5	8	<5	<5	<5	5	**80**	**75**	**70**	**80**

Percent in fraction based on clean sieving in laboratory. Major Fractions in Bold

Table 6-6.
Total Mercury Concentration by Grain Size Fraction

Sample	Fraction	Ground	Hg, ng/g	Percent, Grain Size Fraction	Hg in Size Fraction, ng/g	Percent of Total in Sample	Fraction not Analyzed
E1-7S	> 2 mm	no	1,503	23	345.7	5.2%	55% finer material not analyzed (>100 to <850 μm)
E1-7S	850 μm - 2 mm	no	4,539	22	999	15.1%	
E1-7S	whole	no	6,607	100			
E1-9-SA	> 2 mm	no	149	25	37.3	3.2%	43% finer material not analyzed (>100 to <850 μm)
E1-9-SA	850 μm - 2 mm	no	158	30	47.4	4.0%	
E1-9-SA	whole	no	1,179	100			
E1-9-SB	850 μm - 2 mm	no	138	35	48.3	26.8%	15% coarser; 15% finer (>100 to <500 μm)
E1-9-SB	500 μm - 850 μm	no	230	30	69.0	12.8%	
E1-9-SB	whole	no	180	100			
E2-13-SA	> 2 mm	no	541	85	459.9	2.8%	<5% in finer groups
E2-13-SA	850 μm - 2 mm	no	11,286	10	1129	6.9%	
E2-13-SA	whole	no	16,450	100			
E2-13-SA	> 2 mm	yes	13,815	85	11743	1362%	71.38% using other total
E2-13-SA	850 μm - 2 mm	yes	9,529	10	952.9	110%	5.79% using other total
E2-13-SA	whole	yes	862	100			
E2-13-SG	> 2 mm	no	158	55	86.9	0.5%	10% (>500 to <850 μm)
E2-13-SG	850 μm - 2 mm	no	53,500	30	16050	85.5%	
E2-13 SG	whole	no	18,775	100			
E2-13-SG	> 2 mm	yes	6,210	55	3415	6.6%	
E2-13-SG	850 μm - 2 mm	yes	44,311	30	13293	25.5%	
E2-13 SG	whole	yes	52,075	100			
E5-1	850 μm - 2 mm	no	91,855	25	22964	203%	4% >2 mm; 48% <500 μm
E5-1	500 μm -850 μm	no	9,235	23	2124	18.8%	
E5-1	whole	no	11,321	100			
E5-2 bank A	500 μm -850 μm	no	13,112	25	3278	13.0%	<6% coarser; 29% finer (<100μm)
E5-2 bank A	250 mm - 500 mm	no	7,738	40	3095	12.3%	
E5-2 bank A	whole	no	25,196	100			
E5-2 bottom A	500 μm -850 μm	no	7,827	40	3130.81	8.0%	30% coarser; 10% >2mm, 20 % >850μm - <2mm)
E5-2 bottom A	250 mm - 500 mm	no	40,886	25	10221	26.0%	
E5-2 bottom A	whole	no	39,279	100			
E5-3 bank A	> 2 mm	no	105	50	52.5	1.7%	15 % finer;(>250μm - <500μm)
E5-3 bank A	850 μm - 2 mm	no	110	30	33.0	1.0%	
E5-3 bank A	whole	no	3,162	100			
E5-3 bank A	whole	yes	831	100			
E5-3 bottom A	> 2 mm	no	42	60	25.2	39.2%	21% finer; (>100μm - <850μm)
E5-3 bottom A	850 μm - 2 mm	no	706	20	141.2	220%	
E5-3 bottom A	whole	no	64.2	100			
E5-3 bottom A	whole	yes	150	100			
E5-4 bank A	50 μm - 100 μm	no	2,105	15	315.8	10.7%	10% coarser; (>100μm - <500μm)
E5-4 bank A	5 μm - 50 μm	no	2,741	75	2056	69.8%	
E5-4 bank A	whole	no	2,945	100			
E5-4 bank B	50 μm - 100 μm	no	3,693	12	443.2	16.9%	<8% coarser; >100μm - <500μm)
E5-4 bank B	5 μm - 50 μm	no	5,539	80	4431	169%	
E5-4 bank B	whole	no	2,625	100			
E5-4 bottom A	850 μm - 2 mm	no	810	25	202.5	7.2%	<1% coarser, 10% finer (>100μm - <500μm)
E5-4 bottom A	500 μm -850 μm	no	215	60	129.0	4.6%	
E5-4 bottom A	500 μm -850 μm	no	232	60	139.2	52.9%	
E5-4 bottom A	whole	no	2,805	100			
E5-4 bottom A	whole	yes	263	100			
E5-4 bottom B	850 μm - 2 mm	no	291	40	116.4	39.7%	<5% coarser, 20% finer (<500μm)
E5-4 bottom B	500 μm -850 μm	no	245	35	85.8	29.3%	
E5-4 bottom B	whole	no	293	100			
E5-5 bank A	50 μm - 100 μm	no	795	10	79.5	11.9%	10% coarser; (>100μm-850μm)
E5-5 bank A	5 μm - 50 μm	no	599	80	479.2	72.1%	
E5-5 bank A	whole	no	665	100			
E5-5 bottom A	50 μm - 100 μm	no	423	20	84.6	25.1%	10% coarser; (>100μm - <500μm)
E5-5 bottom A	5 μm - 50 μm	no	563	70	394.1	117%	
E5-5 bottom A	whole	no	337	100			

Comparison of results is hindered by the high variability in the sediment samples. The hypothesis that mercury is highest in the smallest size fraction is not valid for all sediment samples, particularly coarse samples due to the high mercury present if the portion analyzed had grains of cinnabar. Subsequent testing of alternate methods using a different digestion (HF instead of aqua regia) and comparing ground and unground samples was conducted, but the sample heterogeneity precluded consistent results. Grinding sediment samples decreased the variability, but is not preferred due to the potential for losing mercury including any elemental mercury. Some of the pairs had more mercury than the companion unground sample and some samples had less (See results in Appendix B). The better alternative is to take multiple samples, analyze the total and average the results. For comparison of mercury content with grain size, analysis of all size fractions is preferred, although not necessary to determine the fraction with the most mercury.

A series of tests were conducted to estimate the bioavailability of the mercury in the sediments for methylation. A five-step sequential extraction procedure following the method described in Bloom et. al., 2003 was conducted on three sediment samples from the mining area, three near the Alamitos drop structure, and six from the river at Highways 101 and 237. The results are presented in Table 6-7. The F1 fraction uses deionized water that leaches highly water-soluble compounds such as $HgCl_2$ and part of the HgO or $HgSO_4$. The remainder of compounds such as HgO or $HgSO_4$ are leached out in the F2 fraction. The F3 fraction includes weakly-complexed mercury with chloride or organic compounds and methylmercury, if present. The F4 fraction includes elemental mercury, if present, and strongly-complexed mercury such as Hg_2Cl_2 and some strong humic-mercury complexes. The F5 fraction includes cinnabar, metacinnabar, and other insoluble compounds.

The dominant fraction in the sample from the Mine Hill tributary to Jacques Gulch and one of the samples from N. Los Capitancillos Creek was F5, the mercury fraction considered to be mercury sulfides, here cinnabar. The other sample from N Los Capitancillos Creek had a mixture of F3, F4, and F5, indicating that weathering has occurred. The samples from Highway 237 also had cinnabar as the dominant fraction, while those from Highway 101 had a mixture of F3, F4, and F5 fractions. The sum of the bioavailable fraction is considered to be the sum of the first three leaching steps. As shown in Figure 6-8, the samples with high mercury were less bioavailable. For example, the sample with the highest percent bioavailable mercury (50.76 percent) from the Highway 101 location had a total mercury concentration of 180 ng/g. The bottom samples at Highway 237 had lower bioavailability, but because the samples had more total mercury, the amount of bioavailable mercury on a ng/g basis was greater. The percent of bioavailable mercury in the bank samples at Highway 101 and the drop structure ranged from 17.7 to 31.6 percent. Thus, erosion of the banks can introduce bioavailable mercury to the river.

In addition to the full five-step procedure, a one-step leaching procedure was used to estimate bioavailability in coarse sediment samples, since the five-step method is not appropriate for coarse samples. Five samples were analyzed using this procedure, the

Table 6-7.
Sequential Selective Extractions of Mercury in Guadalupe River Sediments

		Mercury Concentrations, ng/g						
Sample ID	**dry fraction**	**F1 (DDW)**	**F2 (pH 2)**	**F3 (KOH)**	**F4 (HNO3)**	**F5 (AQR)**	**sum**	**Sum of F1-F3**
E1-7S	0.754	8.09	0.78	209	434	12,074	12,725	
dry basis		10.7	1.03	277	575	16,013	16,877	
% in fraction		0.06	0.01	1.64	3.41	94.9	100.0	1.71
E1-9SA	0.775	1.18	-0.04	36.4	38.9	25.7	102.1	
dry basis		1.52	-0.05	46.9	50.2	33.1	131.8	
% in fraction		1.16	-0.04	35.6	38.1	25.2	100.0	36.77
E1-9SB	0.796	1.07	0.16	33.0	47.2	1,055	1,136	
dry basis		1.34	0.20	41.4	59.3	1,325	1,428	
% in fraction		0.09	0.01	2.90	4.16	92.8	100.0	3.90
E5-1	0.704	31.0	0.60	811	213	2,015	3,070	
dry basis		44.0	0.85	1,152	302	2,862	4,361	
% in fraction		1.01	0.02	26.4	6.93	65.6	100.0	27.43
E5-2 bank	0.818	10.7	0.57	1,012	501	4,255	5,779	
dry basis		13.0	0.70	1,237	612	5,202	7,065	
% in fraction		0.18	0.01	17.51	8.67	73.6	100.0	17.70
E5-2 bottom	0.691	11.6	0.60	873	442	20,243	21,571	
dry basis		16.7	0.87	1,264	640	29,295	31,217	
% in fraction		0.05	0.00	4.05	2.05	93.8	100.0	4.10
E5-4 bank A	0.757	4.32	0.43	349	344	898	1,596	
dry basis		5.71	0.57	461	455	1187	2,109	
% in fraction		0.27	0.03	21.9	21.6	56.3	100.0	22.20
E5-4 bank B	0.764	3.99	0.62	336	382	1,584	2,306	
dry basis		5.22	0.81	439	499	2,073	3,018	
% in fraction		0.17	0.03	14.6	16.5	68.7	100.0	31.63

Table 6-7. (continued)
Sequential Selective Extractions of Mercury in Guadalupe River Sediments

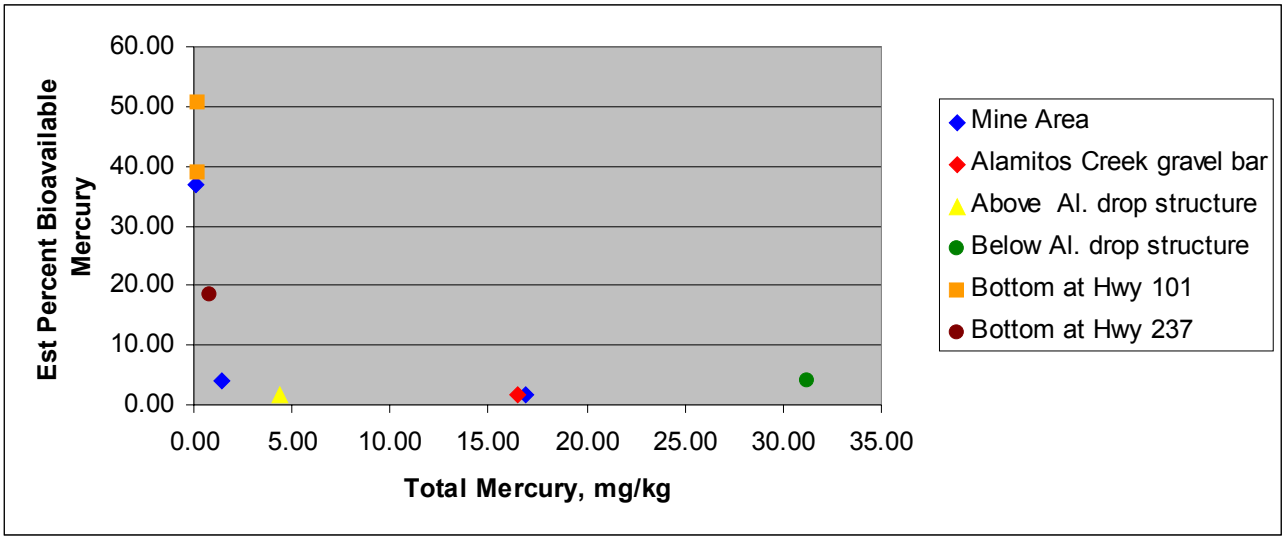
		Mercury Concentrations, ng/g						
Sample ID	dry fraction	F1 (DDW)	F2 (pH 2)	F3 (KOH)	F4 (HNO3)	F5 (AQR)	sum	Sum of F1-F3
E5-4 bottom A	0.742	1.83	0.08	64.3	35.5	28.7	130	
dry basis		2.47	0.11	86.7	47.9	38.6	176	
% in fraction		1.40	0.06	49.3	27.2	22.0	100.0	50.76
E5-4 bottom B	0.743	1.35	0.10	70.9	45.2	67.9	185	
dry basis		1.82	0.13	95.4	60.9	91.4	250	
% in fraction		0.73	0.05	38.2	24.4	36.6	100.0	38.98
E5-5 bank	0.658	0.99	0.88	98.8	165	2,900	3,165	
dry basis		1.50	1.34	150	250	4,407	4,810	
% in fraction		0.03	0.03	3.12	5.20	91.6	100.0	3.18
E5-5 bottom	0.604	1.07	0.24	85.9	29.8	354	471	
dry basis		1.77	0.40	142	49.4	587	780	
% in fraction		0.23	0.05	18.2	6.33	75.2	100.0	18.48

samples analyzed according to Bloom, Preus and Katon Anal. Chim. Acta. 479 pp 233-248 (2003)

gravel bar from Alamitos Creek, a bank and bottom sample from the river at Blossom Hill Road, and bank and bottom samples from the river at Highways 101 and 237. Two of the latter samples were also analyzed using the five-step procedure for comparison. The results for these samples are also shown in Figure 6-8. These samples showed similar results in that the samples with high total mercury had lower percent bioavailable mercury. The full five-step procedure had about 25 percent greater bioavailability than the one-step procedure for the two fine-grained samples tested. The sample from the gravel bar at the mouth of Guadalupe Creek and the coarse bank sample from the river at Blossom Hill Road had low bioavailability (less than 2 percent), compared to the bottom sample from Blossom Hill (10.4 percent). Because the sediment near the drop structure has higher mercury concentrations, the amount of mercury is greater for the same quantity of sediment than for the lower river locations.

6.3 ASSESSMENT OF DATA QUALITY AND CONSTRAINTS

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004a and 2003e) were followed. The QA/QC results for mercury analyses showed that the desired detection limits were achieved, as verified with method blank analyses. The resulting method detection limits (MDLs) in sediment were 0.2 ng/g for total mercury



Estimated Bioavailability of Mercury in Sediment Samples

Sediment Sample	Total Hg, mg/kg	F1-F3 as Percent*
E1-7S Mine Hill Tributary to Jacques Gulch	16.88	1.71
E1-9SA N Los Capitancillos Creek	0.13	36.77
E1-9SB N Los Capitancillos Creek	1.43	3.90
E2-13SA Alamitos Creek above Almaden Lake	16.45	1.56
E5-1 Guadalupe River above Al. Drop Structure	4.36	27.43
E5-2 bank Guadalupe River below Al. Drop Structure	7.06	17.70
E5-2 bottom Guadalupe River below Al. Drop Structure	31.22	4.10
E5-4 bank A Guadalupe River at Hwy 101	2.11	22.20
E5-4 bank B Guadalupe River at Hwy 101	3.02	31.63
E5-4 bottom A Guadalupe River at Hwy 101	0.18	50.76
E5-4 bottom B Guadalupe River at Hwy 101	0.25	38.98
E5-5 bank Guadalupe River at Hwy 237	4.81	3.18
E5-5 bottom Guadalupe River at Hwy 237	0.78	18.48

*Considered estimate of bioavailability based on leaching tests

Sediment Samples Leached with F3 only	Total Hg, mg/kg	Sum of F1-F3 as
E2-13SA	16.45	1.41%
E5-3 bank A	3.16	1.54%
E5-3 bottom A	0.07	10.40%
E5-4 bank B*	2.62	11.53%
E5-5 bank A**	0.66	21.40%

*Comparison with F1+F2+F3: 14.7 %
**Comparison with F1+F2+F3: 26.5 %
Mercury Results are on a dry-weight basis.

Figure 6-8. Comparison of Results from Mercury Bioavailability Tests

and 0.011 ng/g for methylmercury. Sediment samples had high variability, particularly in the coarse samples, which is expected in sediment with a mixture of sand and gravel material comprised of different rock types. However, the analyses of certified reference materials for mercury showed that acceptable accuracy was achieved in the laboratory; the laboratory results were within 99.1 and 101.1 percent of the certified value (NIST-2709 with a total mercury of 1,400 ng/g). The relative percent difference (RPD) value for this material was 1.9 percent. The source of the variability is differences in the actual sediment, as seen by the increased variability of the digestion replicates versus the analytical duplicates The analytical duplicates of a fine-grained field sample had RPD values of 5.4 to 9.4 percent. The percent recovery for the matrix spike duplicates using a fine-grained sample was 84.8 to 92.7 for total mercury, compared to 164.3 to 203.1 percent for a coarse sample. The relative percent difference (RPD) in results for total mercury for these two samples was 9.0 and 21.1 percent, respectively. The RPD values of the coarse samples were within acceptable ranges, although the percent recoveries are greater than desired for the matrix spike duplicates. The RPD values for the certified reference material for methylmercury were 2.6 percent (IAEA-405 with a certified value of 5.49 ng/g). The sediment data are considered usable for data analyses. However, the high variability in samples with a significant sand and gravel fraction needs to be considered.

6.4 COMPARISON WITH PREVIOUS SEDIMENT DATA

The 2004 sediment results have been compared to the sediment samples from Alamitos and Guadalupe Creeks and near the Alamitos drop structure collected for the Synoptic Survey. Sediment samples from the Guadalupe River are also compared to previous samples collected by the USGS and SCVWD.

Synoptic Survey. Previous sediment samples were collected from 16 locations in the creek beds for the Synoptic Survey in summer 2003. The sulfate, sulfide, and mercury concentrations on a dry weight basis are presented in Table 6-7 for the comparable sites from the 2003 and 2004 sampling. Comparisons are summarized below:

- **Sulfate and Sulfide.** One sediment site was sampled at the same general location, on the Guadalupe River below the Alamitos Drop Structure; Site 10 in the Synoptic Survey and Site E5-2 for the 2004 wet season survey. Site 10 was further downstream of the drop structure than Site 5-2. As seen in Table 6-8, sulfate concentrations were similar, 140 mg/kg in E5-2 and 135 mg/kg in Site 10, and adequate in both samples to support potential methylation. Sulfide was higher in the sediment sample from E5-2, 539 mg/kg, compared to 150 mg/kg in the sample from Site 10, which was collected further downstream.

Table 6-8.
Sediment Sample Results from July 2003 in Vicinity of 2004 Locations

Site Number	Site Name	Dry Fraction	Sulfate mg/kg dry	Sulfide mg/kg dry	Hg ng/g dry	MeHg ng/g dry	MeHg percent
Site 7	upstream of Almaden Lake	0.814	63	8.22	21,510	4.56	0.021
Site 10	Guadalupe River below of drop structure	0.267	135	150	69,511	1.70	0.002
Site 13	Guadalupe Creek upstream of Almaden Expwy.	0.389	62	82.9	21,963	2.29	0.010

Reference: Tetra Tech, 2003a

- **Total Mercury.** The intent was to sample locations that had not been previously sampled, so only three locations were collected in areas common between the 2003 and 2004 field sampling events. The two samples from the gravel bars of Alamitos Creek above its confluence with Almaden Lake (E2-13SA) and Guadalupe Creek at its confluence with Alamitos Creek (E2-13SG) had lower total mercury concentrations than the previous samples from further upstream in the two creek beds (Sites 7 and 13), respectively. The gravel beds sampled in 2004 are submerged in the summer by Almaden Lake and the impoundment above the Alamitos drop structure. The higher total mercury concentrations in the upstream samples indicate that there is a potential for future downstream transport of higher mercury sediment.

- **Methylmercury.** The methylmercury concentrations in the gravel bar samples were considerably less than the upstream sediment samples from Sites 7 and 13, which is expected given the coarse nature of the sediment from the two gravel bars and the colder conditions when the samples were collected in March 2004. In contrast, methylmercury in the two bottom sediment samples from below the drop structure (2.1 and 3.23 ng/g at E5-2) were higher than the previous summer measurement (1.7 ng/g at Site 10). The summer methylmercury concentrations in sediment from above Almaden Lake were higher than in March 2004 (4.56 ng/g at Site 7 and 1.76 to 35.85 ng/g upstream in Alamitos Creek).

USGS Survey. Sediment samples were collected in the vicinity of the 2004 samples from the Guadalupe River in October 2000 by the USGS at the Alamitos Fish Ladder (which is at the Alamitos drop structure), at Almaden Expressway, and at Alviso Slough (Thomas et al, 2002). The data from sites at nearby locations to the 2004 sampling sites are presented in Table 6-9.

Table 6-9.
Sediment Sample Results from October 2000 in Vicinity of 2004 Locations

Site Number	Site Name	Percent Fines	Hg ng/g dry	MeHg ng/g dry	MeHg percent
Site F	Upstream of Alamitos Fish Ladder	41	33,410	7.79	0.03
Site T	Guadalupe River. at Almaden Expwy	3	2,770	1.71	0.06
Site S	Guadalupe River at Alviso Slough.	100	880	0.90	0.10

Reference: Thomas et. al., 2002

- **Total Mercury**. In contrast to the October 2000 results, both the Synoptic Survey and 2004 sampling data sets, the total mercury in sediment samples was higher below the drop structure, possibly due to transport during the large floods that occur, such as in December 2002 and January and February 2004. The sediment sample from Alviso Slough (880 ng/g) had similar total mercury concentrations to one of the bottom samples from Highway 237 (772 ng/g); the other sample was lower (337 ng/g). The samples from Highway 237 are also similar to additional samples collected in July 1999 and 2000 where the total mercury ranged from 200 to 700 ng/g (Conaway et. al., 2003) in the lower reach of the Guadalupe River.

- **Methylmercury**. The October 2000 sample from above the fish ladder had higher methylmercury concentration than the sample from the river at Almaden Expressway. The methylmercury concentration above the fish ladder (7.8 ng/g dry) in October was higher than in March (2.4 ng/g), as expected due to the warmer conditions. The sediment sample from Alviso Slough also had higher methylmercury than the 2004 bottom samples, but was similar to the bank samples.

SCVWD. Total mercury has been measured in sediment from the Guadalupe River from below the Alamitos drop structure to Alviso Slough.

- **Total Mercury**. Sediment total mercury concentrations were high just below Almaden Lake (average of 42,000 ng/g), similar to the 2004 results (39,279 ng/g). Samples from the lower part of Guadalupe River near Alviso Slough had total mercury concentrations of about 400 ng/g, similar to the 2004 results (337 to 772 ng/g) at Highway 237.

The sediment data from the various sampling events show high total mercury concentrations in the vicinity of the Alamitos Drop Structure and much lower concentrations in the lower reach of the Guadalupe River closer to the Bay.

7.0 HYDROLOGY FOR ESTIMATING MERCURY LOADS

Elevated flows in the creeks of the Guadalupe River Watershed result in increased total suspended sediment concentrations (TSS), with a concomitant increase in total mercury concentrations. The transport of mercury loads in the watershed is therefore strongly dependent on the flows in the different creeks and the main stem of the river. This section presents an overview of the rainfall and creek and river flows in different locations of the watershed, with a special focus on flow data that are needed to evaluate mercury loads.

7.1 PRECIPITATION

The Guadalupe River Watershed has a Mediterranean-type climate generally characterized by moist, mild winters and dry summers. The measurable precipitation is in the form of rainfall, 85 percent of which occurs between November and April. Mean annual precipitation ranges from 48 inches in the headwaters above the Guadalupe and Almaden Reservoirs to 14 inches at the Central San Jose rain gauge. Temperatures range from below freezing in the mountains for a few days in winter to nearly 100 °F in the hottest parts of the valley in the summer.

A representative picture of the precipitation is shown in Figure 7-1, using data for the 2003-2004 wet season from eight rain gages spread across the watershed: one near each of the four reservoirs, two in the high elevation areas above Guadalupe and Lexington Reservoir, and two in the lower elevation, urbanized areas. These data were obtained from the SCVWD ALERT system (http://alert.valleywater.org/). In addition to dependence on elevation, there is also a west to east gradient in elevation, with Station 1513 near Calero Reservoir (20") about a third lower than Station 2068 near Lexington reservoir (30"). The lower elevation stations (2065 and 1453) received 12.9" and 12.4" of rainfall. These rainfall quantities correspond to return periods of approximately 2 years according to the return interval calculations of McKee et al. (2004).

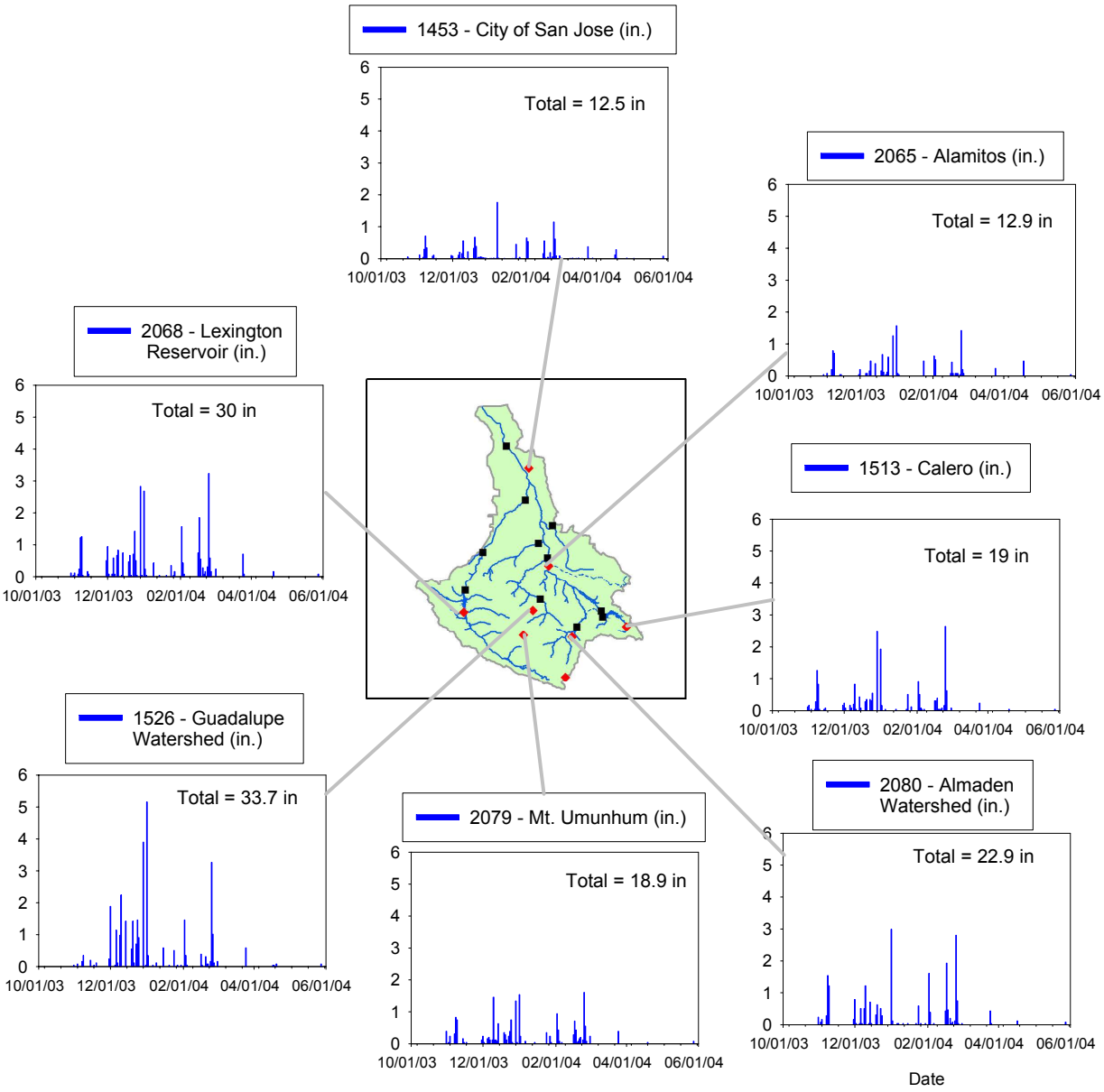


Figure 7-1. Measured rainfall for selected rain gages in the Guadalupe River Watershed. The numbers at the top of each plot are the identifiers for the individual gages. Data were obtained from the SCVWD ALERT system (http://alert.valleywater.org/). The y-axis in each plot shows rainfall in inches and the x-axis shows the date between 10/1/2003 and 5/31/2004. The black symbols identify stream gages and data from them are plotted in Figure 7-2.

7.2 GAGED FLOWS

Flows in the Guadalupe River Watershed are measured at 10 locations, one each downstream of the four main reservoirs (Guadalupe, Almaden, Lexington, and Calero Reservoirs) and Vasona Reservoir, on Ross, Canoas, Los Gatos Creeks, and at two locations in Guadalupe River, one below the fish ladder and one in downtown San

Jose. The Guadalupe River station below the fish ladder (Station 1445) only reports valid flows when it is not spilling, and the total flows are below 57.2 cfs.

The flow patterns over the 2003-2004 wet season are shown in Figure 7-2, using data downloaded from the SCVWD ALERT system (http://alert.valleywater.org/). As can be seen in this figure, outflows from the reservoirs are less variable than flows in the creeks and the river. During storm events, flows in the creeks and the river are much more variable with peak values increasing dramatically. Reservoir outlet flows increase periodically due to controlled releases that may or may not occur near the dates of storm events. Over the course of the 2004 wet season sampling reported here, reservoir flows were generally low.

A more comprehensive picture of the flows was obtained for the Guadalupe River at the USGS station downstream of the confluence with Los Gatos Creek at St. Johns Street, shown in Figure 7-3. The median flow in the Guadalupe River at the USGS gauge at St. Johns Street was 1 to 16 cfs between 1956 and 1998, which is dominated by the dry season. In the wet season, flows increase substantially during storm events. Between 1930 and 1998, peak flows at the USGS gauge varied from 125 cfs in 1960 to 10,500 cfs on March 10, 1995. The large flows, such as in 1995 and 1998, resulted in flooding of the downtown area of San Jose. Flows rise quickly during winter storms with the peak occurring within 24 to 48 hours, and then return to normal flows over a period of a few days. The degree of flooding of the lower Guadalupe River is affected by the available capacity of the reservoirs at the time of a large storm event and the areal extent of precipitaiton.

7.3 MODELED FLOWS

To compute mercury loads, hydrologic modeling was used to estimate flows in sub-basins where no flow gage data were available. This was especially true for the upper part of the watershed, where flow measurements, made in association with mercury concentration measurements, were available only for a limited number of sampling dates. However, these snapshots of flow were inadequate for estimating the flow variability and the total flows occurring in these watersheds. Because some of these ungaged watersheds drained the historic mining areas, knowledge of flows was especially important from the standpoint of estimating mercury loads.

The model used for estimating flows was the Soil and Water Assessment Tool, version 2000 (SWAT2000) developed by the USDA, ARS, and the Texas A&M Spatial Sciences Laboratory. The development of SWAT was funded by the EPA and is incorporated into EPA's BASINS 3.0 water quality modeling system. SWAT has undergone a series of updates and improvements since its first release. In addition to revisions in model process representation, a complete ArcView GIS interface for the model was developed (Neitsch and DiLuzio, 1999) and subsequently incorporated into the EPA BASINS package (U.S. EPA, 2001). SWAT (Neitsch et al., 2001) is a long-term, continuous watershed simulation model. This model simulates land cover impacts with weather, soil, topography, and vegetation data. The SWAT simulation

and output is organized by Hydrologic Response Units (HRUs), which are areas with homogeneous land cover and soil properties.

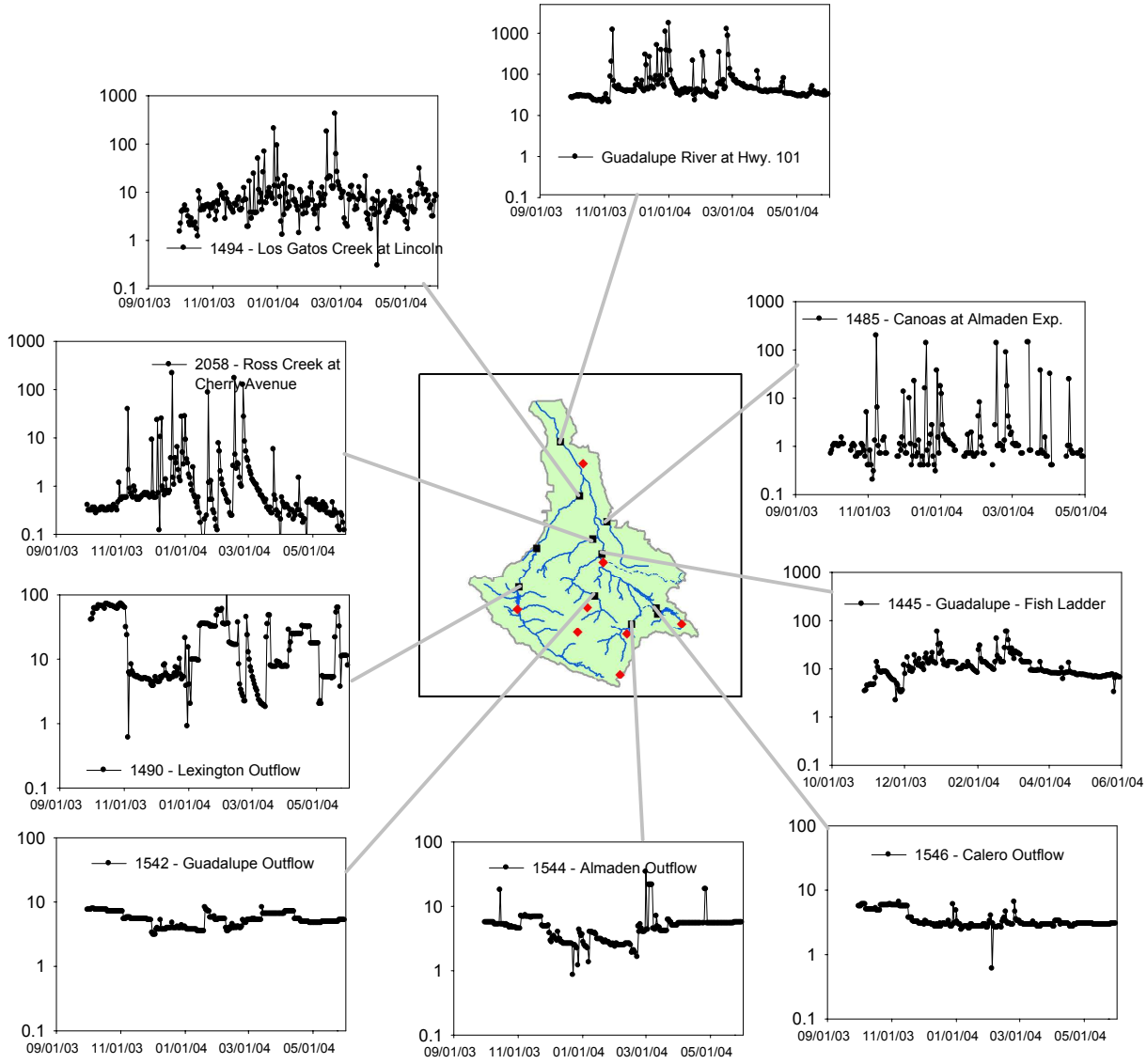


Figure 7-2. Measured flow for selected gages in the Guadalupe River Watershed. Data were obtained from the SCVWD ALERT system (http://alert.valleywater.org/). The y-axis in each plot shows flows in cfs and the x-axis shows the date between 10/1/2003 and 5/31/2004. The red symbols identify rain gages and data from them is plotted in Figure 7-1.

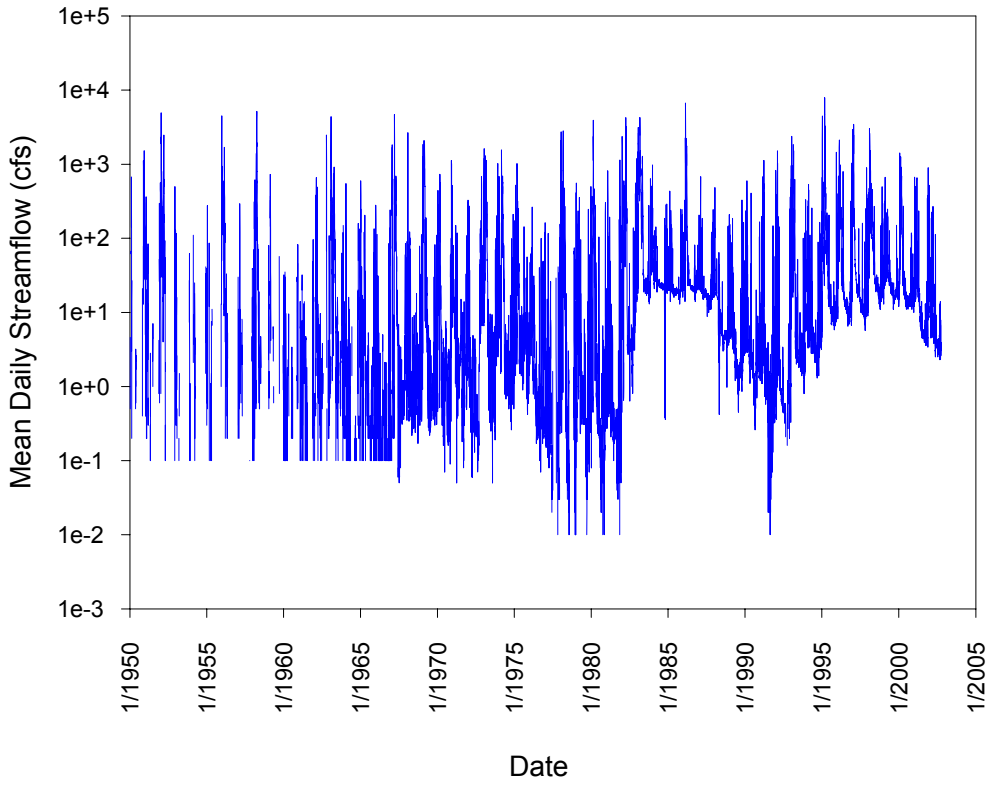


Figure 7-3. Mean daily streamflow in the Guadalupe River at downtown San Jose. Data obtained from USGS (http://water.usgs.gov/).

Within SWAT, runoff is simulated separately for each HRU, aggregated to the sub-watershed level, and then routed to calculate total runoff and pollutant delivery. The model considers moisture and energy inputs, including daily precipitation, maximum and minimum air temperatures, solar radiation, wind speed, and relative humidity. SWAT simulates a complete set of hydrologic processes including canopy storage and evapotranspiration. For upland generation of flow and sediment, SWAT relies on the well-tested, semi-empirical approaches of the SCS Curve Number and Modified Universal Soil Loss Equation (MUSLE). The time step of the model is one day. For the Guadalupe TMDL, SWAT was used to predict flow for several small sub-basins in the watershed. Model defaults were used, except for precipitation gage data from the Guadalupe watershed, discussed above, and landuse/landcover data from the California GAP Analysis. The National Gap Analysis Program (GAP) has developed land cover data to provide detailed information on the distribution of common species. The data for California provides a list of co-dominant species and habitat type for each small-scale polygon. It provides more detailed information about vegetation type compared to the BASINS-default land cover data.

Sub-basins selected for modeling using SWAT were intended to cover a range of landuse and topographic conditions in the Guadalupe Watershed. The sub-basins modeled were Soda Spring, Upper Guadalupe Creek, Golf Creek, Herbert Creek, and

Cherry Canyon Creek. Modeled flows from these sub-basins are shown in Figure 7-4.

7.4 DATES OF WET WEATHER SAMPLING

Because an important objective of the wet weather sampling was to measure mercury concentrations during storm events, samples were collected across the watershed during storms that occurred between mid-February (after approval of the Data Collection Plan) and late May. Sampling was conducted on one or more consecutive days starting on 2/26/04, 3/2/04, 3/8/04, 3/26/04, 4/14/04, 4/19/04, and 4/23/04. A detailed profile of the rainfall over this period, shown in Figure 7-5, shows the proximity of these sampling dates to the main rain events over the data collection period.

7.5 CONCLUSIONS

Because of the linkage between flows, mercury concentrations, and transported mercury loads, and because flows in the Guadalupe River Watershed are highly variable over the wet season, accurate knowledge of flows over time are essential for accurate load estimates. This was easily accomplished at locations that were continuously monitored with automatic flow gages. However, such data were not available for significant portions of the watershed, including some portions of major consequence for mercury loads, and these flows were estimated through hydrologic modeling.

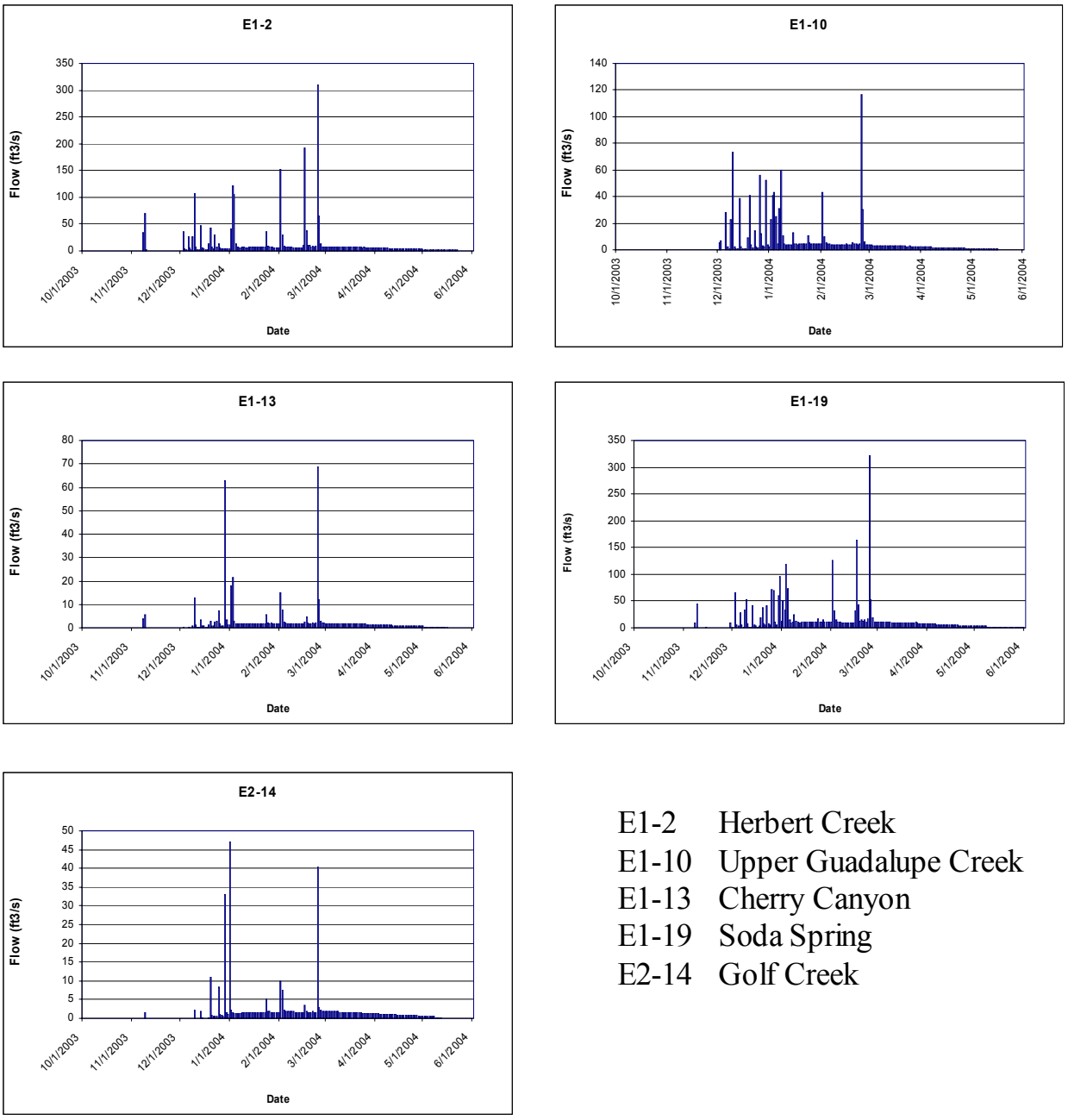


Figure 7-4. Modeled flows, using the Surface Water Assessment Tool (SWAT) for five representative sub-basins within the Guadalupe Watershed. Flows were modeled at the locations identified by the sampling stations.

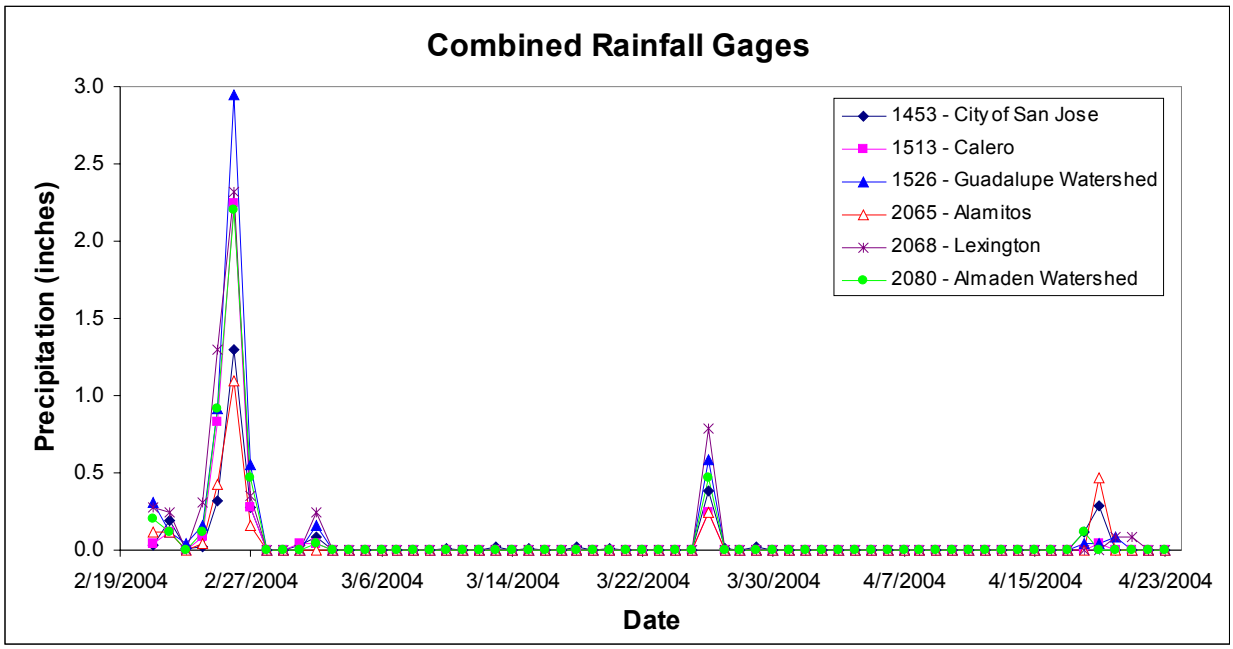


Figure 7-5. Rainfall measured at selected gages during the period of sampling for this study.

8.0 MERCURY LOAD ESTIMATES

Using the wet-weather data described in the previous sections, we put together an estimate of the movement of mercury loads through the Guadalupe River Watershed. The key data elements that were used in developing this estimate were the flows, suspended solids, total and dissolved mercury concentrations, and methylmercury concentrations. The measured total mercury concentration for a water sample includes dissolved and particulate mercury, and the methylmercury in the sample can exist in both the dissolved and particulate phases. Loads were estimated in this chapter for total mercury, dissolved mercury, and methylmercury. Because of the way in which the concentrations are measured, there is an overlap between the different loads: total mercury loads include a fraction that is in dissolved and methylmercury form, and dissolved mercury loads contain a portion that is in the methylmercury form. However, identifying loads in three chemical forms provides a basis to compare the relative bioavailability of mercury from different sources. The concentration data measured in field samples were associated with landuse maps to relate mercury concentrations to different land uses. Measured flow data, which were limited in the upper part of the watershed, were supplemented with model-estimated flows to obtain estimates of mercury loads in runoff. Modeled flows were used only in those situations where no flow gage data were available.

We divided the watershed into several groups of water bodies to develop correlations between flows and concentrations that would be the basis for computing mercury loads. These groupings were based on the similarity in the topography and land use, and also the anticipated similarity in mercury sources, transport, and transformation characteristics. Sampling stations on the water bodies were classified into the following six categories: 1) creeks upstream of the reservoirs draining areas not known to contain mines, defined as the background subwatersheds, 2) creeks that drain the historic mercury mine areas, upstream of Guadalupe and Almaden Reservoirs, 3) Guadalupe Creek, 4) Alamitos Creek, 5) creeks draining mostly urban areas, and 6) Guadalupe River. The names of water bodies within each group, and the identifiers of the stations sampled, are shown in Table 8-1. Some sampling stations, that did not clearly fall into one of these groups, were not included in these

lists. Further, when the data were similar enough, some of the groups were joined together to develop a combined correlation.

The general approach taken to estimate the loads of different mercury forms (total, dissolved, and methylmercury) being transported through the Guadalupe River Watershed can be divided into the following steps:

1. The measured flow in creeks was related to the suspended solids on the sampling dates; separate correlations were developed for each of the water body groups listed above.
2. The suspended solids concentrations were related to the total mercury concentrations, with separate correlations for different water body groups as above.
3. Concentrations of dissolved mercury and methylmercury were related to the total mercury concentrations. Correlations were obtained for different water body groups as above.
4. Daily flows over the entire wet season, assumed to cover the period from Oct 1, 2003 to May 31, 2004, at selected stations were obtained from gages. In the absence of continuous gage data, flows were estimated through modeling.
5. Daily loads over the wet season at specified creek locations within the watershed were estimated using the flows and the estimated concentrations in 1), 2), and 3) above.
6. The wet season load flowing through creeks for 2003-2004 was the sum of the product of the daily loads for each of the three mercury species.
7. In addition to these load estimates for transport through creeks, non-point mercury loads from undeveloped, urban, and historical mine areas were also estimated from watersheds that were dominated by one type of land use. These areal non-point loading rates were used to estimate the loads that were flowing into creeks. In the event that the loads flowing out of creeks, estimated in 6), were significantly lower or higher than loads flowing in, these were indicative of settling or sediment re-suspension processes.

The approach summarized above was used to develop seasonal load estimates using mercury concentration data from a small number of sampling dates. At the heart of this calculation are the correlations between flows and concentrations of suspended solids and mercury. The stronger these correlations, the more robust the estimates of the loads that can be made. Given that data set we were working with, and the errors associated with the individual correlations, an uncertainty analysis was also performed to estimate a distribution of total mercury loads flowing out of the Guadalupe River. The uncertainty analysis provides the range of possible loads, given a data set, and can be used to determine whether the accuracy is sufficient for the management decisions to be made. The accuracy can be improved by the collection of additional data, particularly if those data span a wider range of flow conditions than observed during the sampling dates of this wet weather study.

The remainder of this section describes each of the load calculation steps and the uncertainty analysis in greater detail.

Table 8-1.
Classification of stations for developing flow and concentration correlations.

Background subwatersheds (upstream of reservoirs)	
E1-02	Herbert Creek
E1-03	Jacques Gulch above MH
E1-04	Barret Canyon
E1-05	Larrabee Gulch
E1-10	Upper Guadalupe Creek
E1-11	Rincon Creek
E1-13	Cherry Canyon
E1-14	Pine Tree Canyon
E1-18	Limekiln Canyon
E1-19	Soda Spring
E1-20	Briggs Creek at CDF
E1-20up	Briggs Creek at Bear Creek Road
E1-21	Upper Los Gatos Creek
E1-22	Lyndon Canyon
E2-02A	Cherry Springs Creek
E2-03	Pheasant Creek
E2-04	Shannon Creek
Creeks Draining Historic Mercury Mining Areas	
E1-06	West Tributary from Mine Hill to Alamitos Creek
E1-07	Mine Hill Tributary to Jacques Gulch
E1-09	N. Los Capitancillos Creek
E2-08	Deep Gulch at previous site
E2-14	Golf Creek upstream of Alamitos Creek
E2-16	Randol Creek upstream of Alamitos Creek
Guadalupe/Alamitos Creek	
E2-09	Alamitos Creek at bridge near AQCP
E2-10	Alamitos Creek at Harry Road
E2-11	Alamitos Creek at Greystone Ln
E2-12	Alamitos Creek above Almaden Lake
E2-01	Guadalupe Creek upstream of Cherry Springs Creek
E2-05	Guadalupe Creek at Old Gauge
E2-06	Guadalupe Creek below Masson Dam
E2-07	Guadalupe Creek above Almaden Expressway
Creeks Draining Urban Areas	
E3-01	Ross Creek upstream of Guadalupe River
E3-02	Canoas Creek at Lean Ave
E3-03	Canoas Creek at Dow Drive
E3-04	Canoas Creek upstream of Guadalupe River
E3-06	Los Gatos Creek at Camden Ave
E3-07	Los Gatos Creek upstream of Guadalupe River
Guadalupe River	
E4-01	Guadalupe River abv ALM DS
E4-02	Guadalupe River below ALM DS
E4-03	Guadalupe River at Blossom Hill Rd
E4-04	Guadalupe River upstr Ross Cr
E4-05	Guadalupe River upstr Canoas Cr
E4-06	Guadalupe River at San Carlos Street
E4-07	Guadalupe River at Hwy 101
E4-08	Guadalupe River at Hwy 237

8.1 RELATING FLOW TO TOTAL SUSPENDED SOLIDS

In general, the ability of a flowing water to carry total suspended sediment (TSS) load increases as the flow velocity increases. At a specific location in a stream, it is possible to develop strong correlations between flow and TSS as has been done in Guadalupe River near the downstream edge of this watershed (McKee et al., 2004). However, if data on flow and suspended sediments from different locations and streams are combined, the correlations are may be less strong because of differences in the watersheds. For this study, we did not have the luxury of a large number of co-located flow and TSS measurements at a single location. Instead, flow and TSS data were distributed over a large number of stations throughout the watershed. Rather than incorporate all these data into one relationship, we chose to correlate flow and TSS for six distinct groups of water bodies: reservoir outlets, creeks in the upper watershed (upstream of Guadalupe and Almaden Reservoirs) draining the historic mercury mine areas, creeks upstream of the reservoirs draining areas not known to contain mines, creeks downstream of Guadalupe and Almaden Reservoirs, creeks draining mostly urban areas, and the main stem of the Guadalupe River. The flow-TSS correlations for Guadalupe River Watershed are plotted in Figure 8-1. The regression equations for the lines shown in Figure 8-1 are presented in Table 8-2.

Differences in the regression lines for the different water body groups are a result of the variety of landuses, topography, and creek types represented by the stations used in Figure 8-1. Thus, for the same flow rate, the TSS values in urban creeks are about five times higher than the background creeks. The correlation coefficients (r^2 values) shown in Table 8-2 are generally low and are a consequence of the limited range of flow data available and the inclusion of multiple stations within each group of water bodies. Data collected at these locations in future years may help to improve the correlations, and thereby to reduce the uncertainties in estimated TSS. For the specific case of Guadalupe River, the regression we have obtained can be compared with that obtained by McKee et al. (2004) as shown in Figure 8-2. This relationship was based on a far more extensive data collection (albeit at only one location in the entire watershed) and it can be seen that the regression from data collected by Tetra Tech is generally consistent with the McKee et al. equation. Note, however, that this equation was replotted from the McKee et al. report and no estimate of r^2 for this relationship was available.

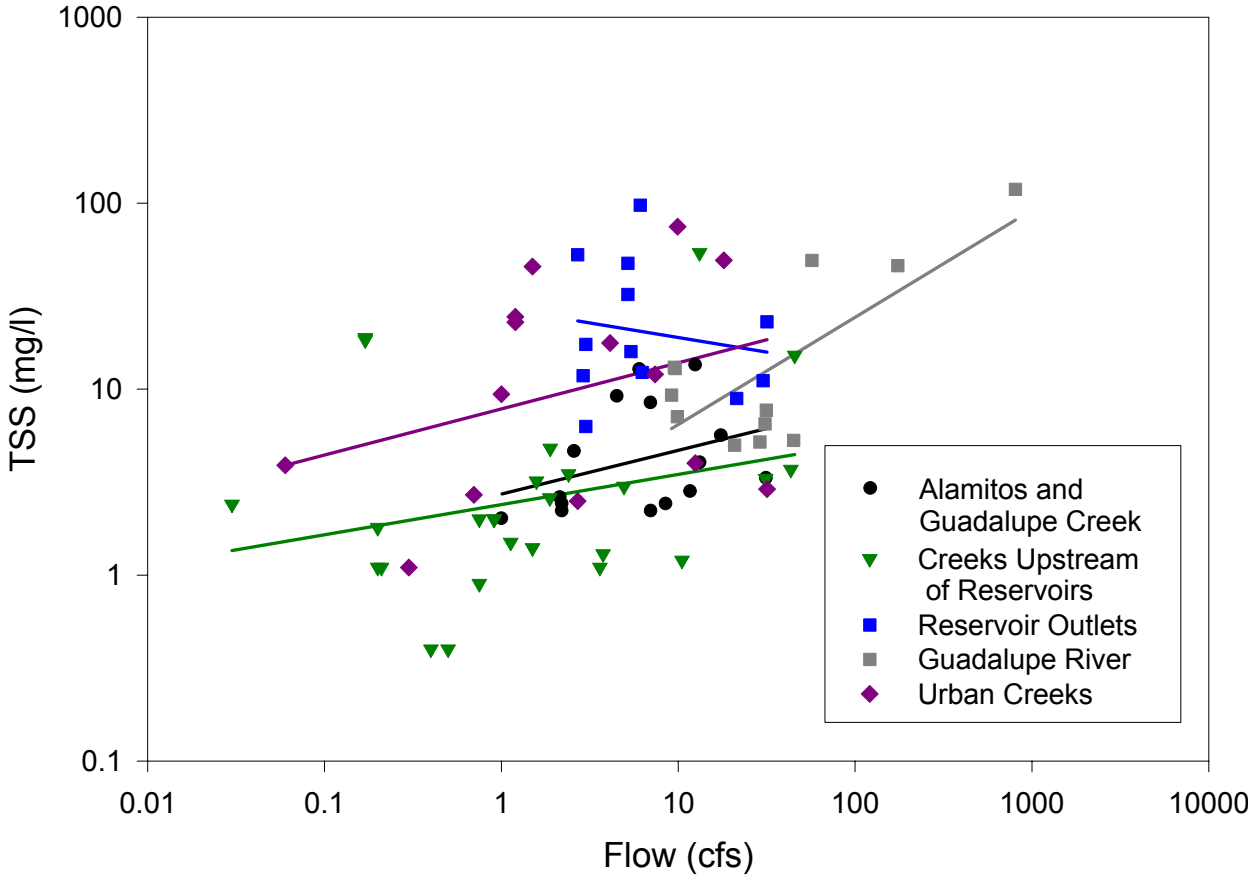


Figure 8-1. Relating flow and total suspended solids in different groups of water bodies in the Guadalupe River Watershed. The water body groups are identified in Table 8-1.

Table 8-2. Intercepts, slopes, and correlation coefficients for the regressions between flow and total suspended solids for different water body groups.

Water Body Group	Intercept*	Slope*	r^2
Alamitos and Guadalupe Creek	0.43	0.23	0.11
Mining and Background Creeks (upstream of reservoirs	0.38	0.16	0.067
Reservoir Outlets	1.43	-0.15	0.03
Guadalupe River	0.23	0.58	0.55
Urban Creeks	0.89	0.24	0.1

*Slope and intercept are based on regressions of log(flow) and log(TSS)

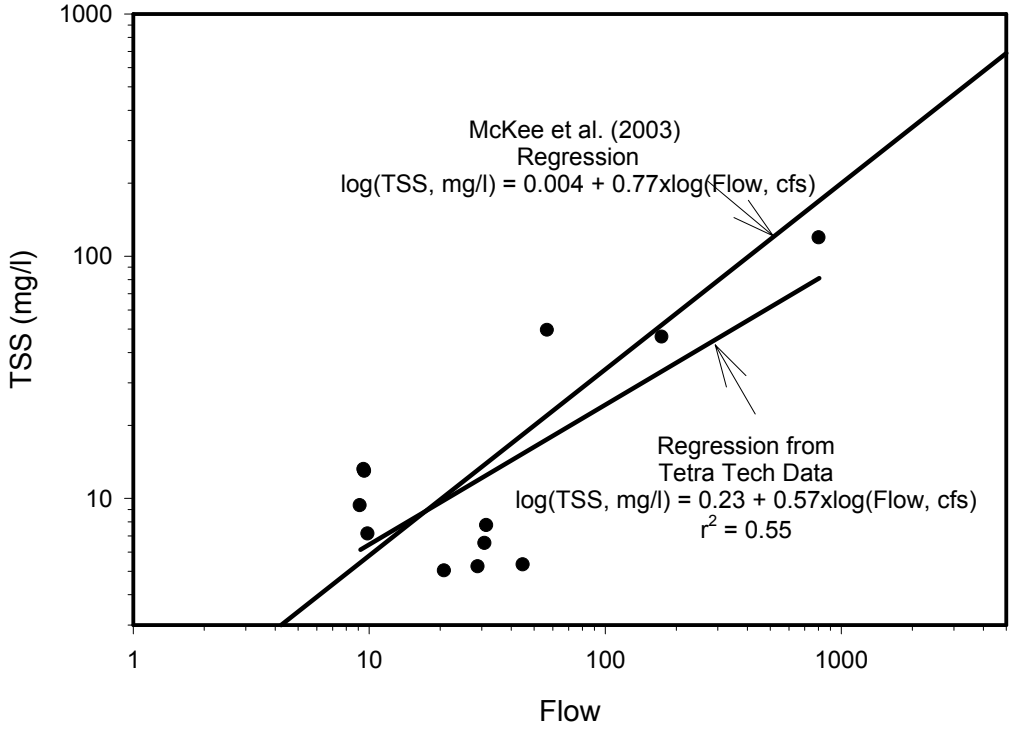


Figure 8-2. Comparing the flow-TSS relationship for Guadalupe River obtained in this study to that reported by McKee et al. (2004) where detailed flow and suspended solids measurements were made at one location. The McKee et al. equation was recreated from the published report, no r^2 information was available.

8.2 RELATING TOTAL MERCURY TO TSS

Because of the strong association of mercury with particulate matter, total mercury concentrations are well-correlated with TSS. A single TSS-total Hg correlation for the entire watershed is inappropriate because suspended sediments from different locations in the watershed may contain mercury at different concentrations, as shown in Figure 8-3. Concentrations of mercury in suspended sediment from areas draining mines and the Guadalupe River may be an order of magnitude or more greater than what is seen in background areas. For this reason, in a manner similar to that used in Section 8.1, we chose to relate TSS and total mercury for different groups of water bodies, with different resulting regression equations for each group. The five different groups were: creeks upstream of the reservoirs draining areas not known to contain mines, Guadalupe Creek, Alamitos Creek, creeks draining mostly urban areas, and the main stem of the Guadalupe River. These relationships and the resulting regression equations are shown in Figure 8-4 (a) through (d). Although the slopes of the lines are different, reflecting the variation in sediment-bound mercury, most of the r^2 values for the equations are greater than 0.5, indicating fairly strong correlations between TSS and total mercury within each of the water body groups. An interesting observation was the difference in the slopes of the regressions for

Alamtios Creek and Guadalupe Creek in Figure 8-4 (c). Although both these creeks carry runoff from the historic mines, mercury concentrations in sediments in Guadalupe creek are diluted by runoff from non-mining creeks to a greater extent. The small creeks draining the historic mining areas were not included in this set of figures, because these data were extremely variable, in part depending on the fraction of the watershed that was covered by historic mines. Mine loads were estimated using the approach described in Section 8.5, and using GIS information on the extent of the historic mines within each subwatershed.

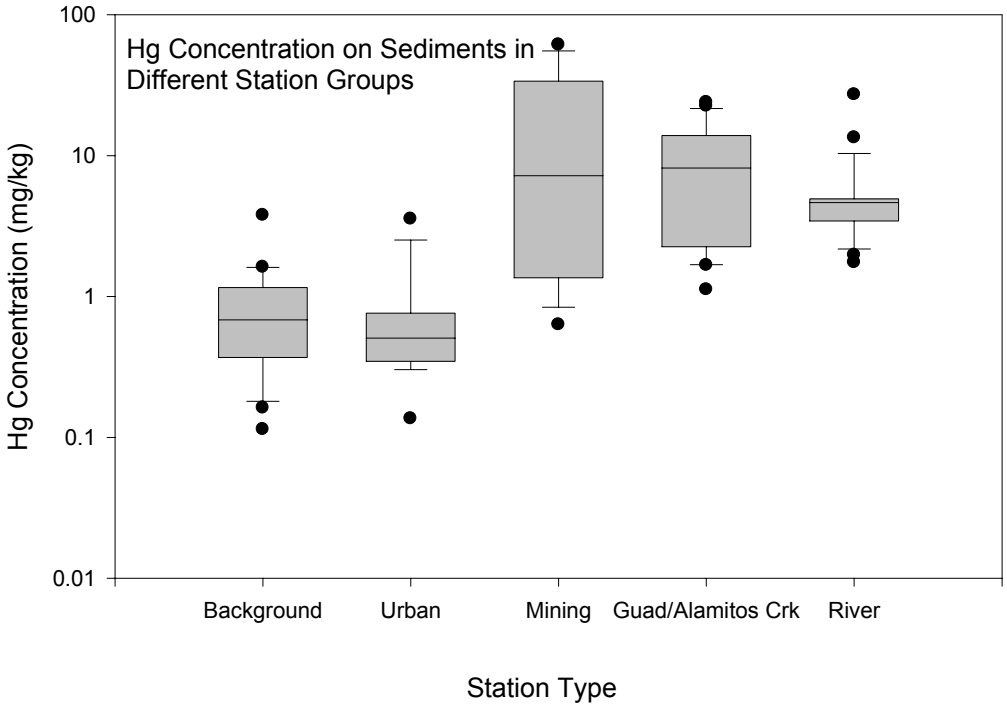


Figure 8-3. Concentrations of mercury on suspended sediments in water samples collected from different groups of water bodies in the Guadalupe River Watershed.

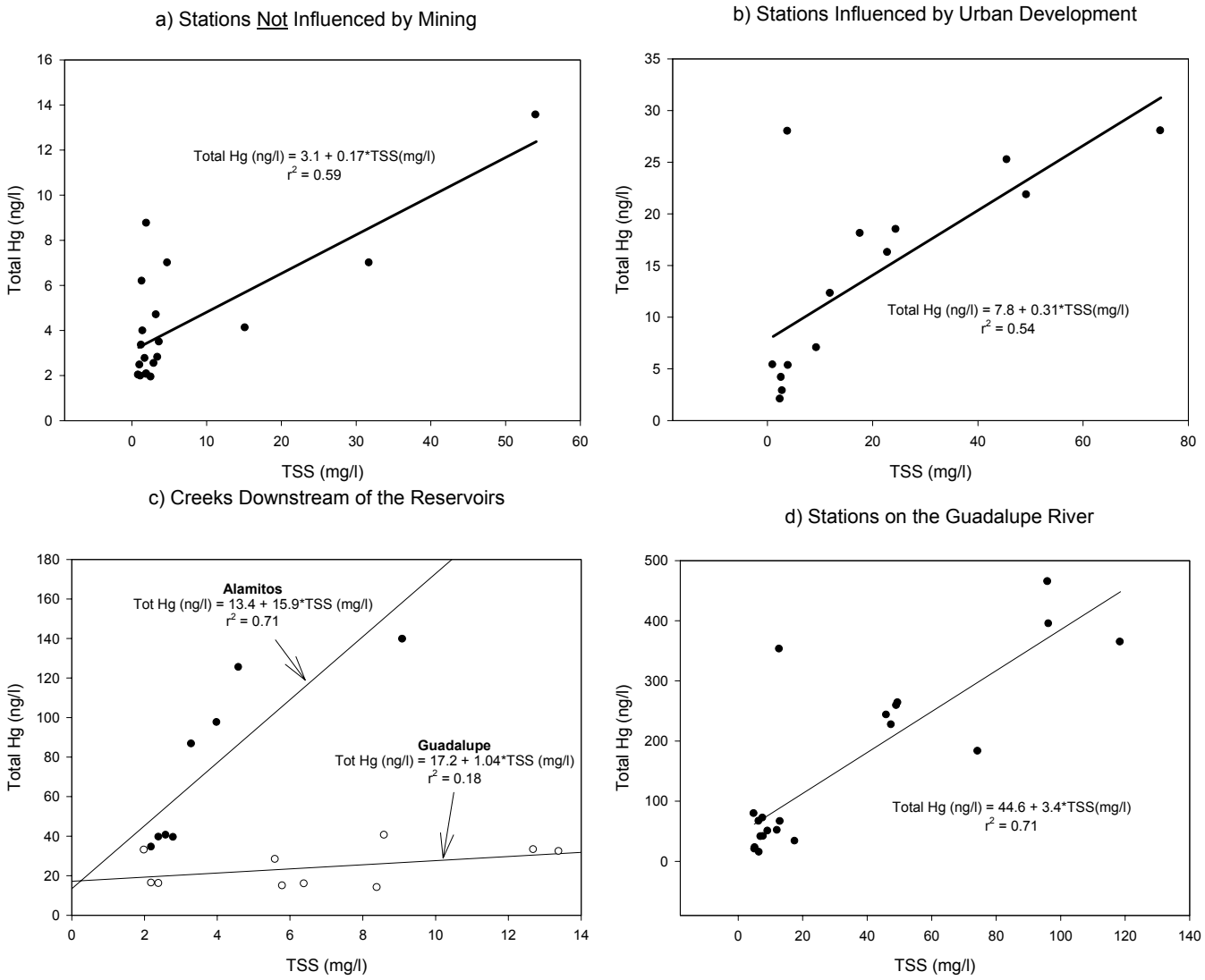


Figure 8-4. Relating TSS and total mercury in different groups of water bodies in the Guadalupe River Watershed. The water body groups are identified in Table 8-1.

8.3 RELATING DISSOLVED AND METHYLMERCURY TO TOTAL MERCURY

Elevated total mercury is a necessary, although not a sufficient, condition for the presence of dissolved and methylmercury at elevated levels. For elevated concentrations of dissolved and methylmercury to occur, suitable aquatic chemistry conditions need to be present. Thus, anoxic conditions are likely to result in the dissolution of particulate mercury when present in cinnabar form, and also to lead to the formation of methylmercury. Alternatively, low pH conditions may increase the dissolution of mercury that is present as an adsorbed phase in sediments. Also, low flows may be more influenced by porewater diffusion from sediments, the zone where mercury methylation is likely to occur. Despite the complexity of the relationship between different forms of mercury, it is worthwhile to attempt to relate total mercury to the other main species using the approach above, where the water

bodies are divided into seven groups with similar properties. The data are plotted for dissolved mercury in Figure 8-5, and for methylmercury in Figure 8-6. The corresponding regression equations are shown in Tables 8-3 and 8-4. Although there are broad similarities in the plots, in that both dissolved mercury and methylmercury increase as total mercury increases, there are significant differences in the concentrations of the dependent species for a given value of total mercury. The differences between the regression equations are indicative of the different aquatic environment within each group of water body. Thus, depending on the water body group being considered, a given total mercury concentration can result in methylmercury values that vary from a factor of 2 to 5 times. The results shown in the plots provide support for the separation of water bodies into different groups for developing the regression equations.

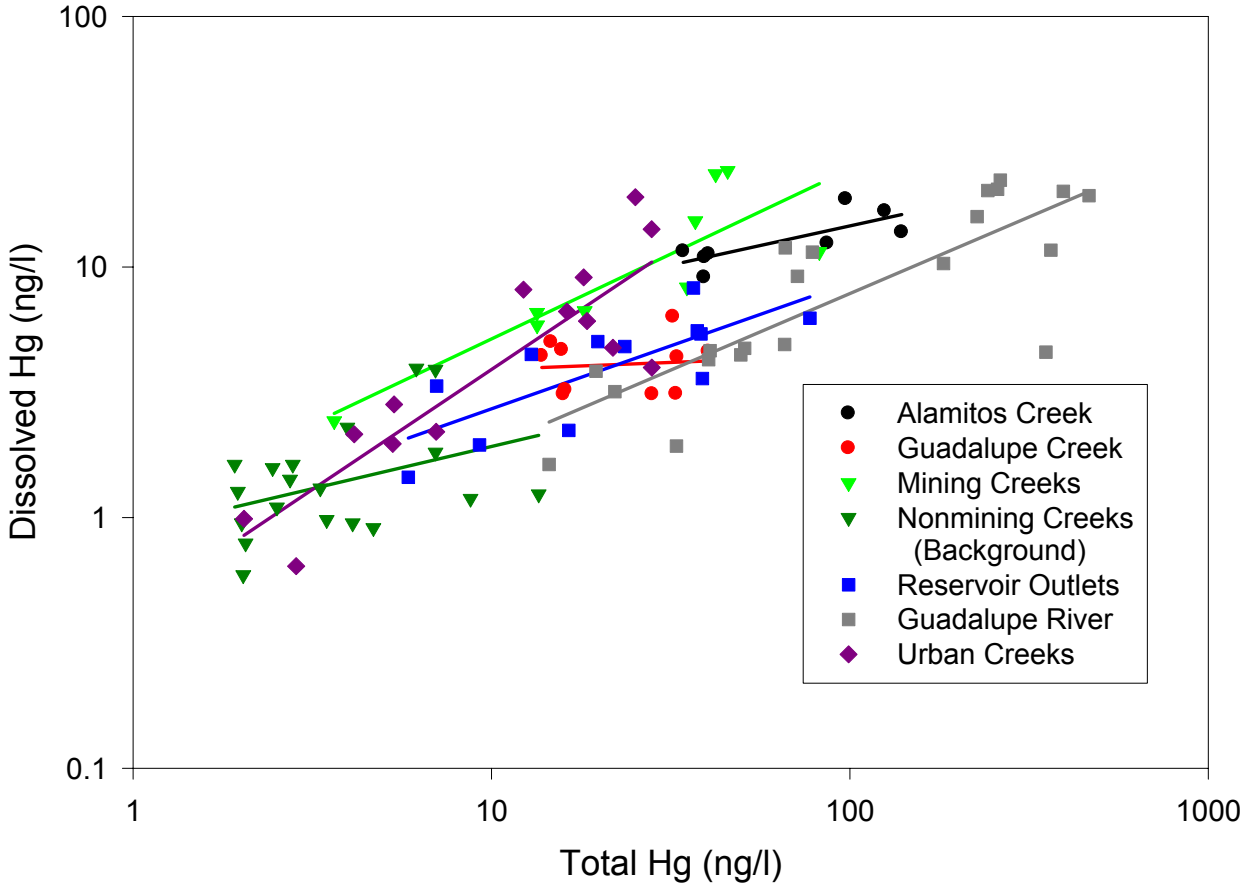


Figure 8-5 Relating total and dissolved mercury in different groups of water bodies in the Guadalupe River Watershed. The water body groups are identified in Table 8-1.

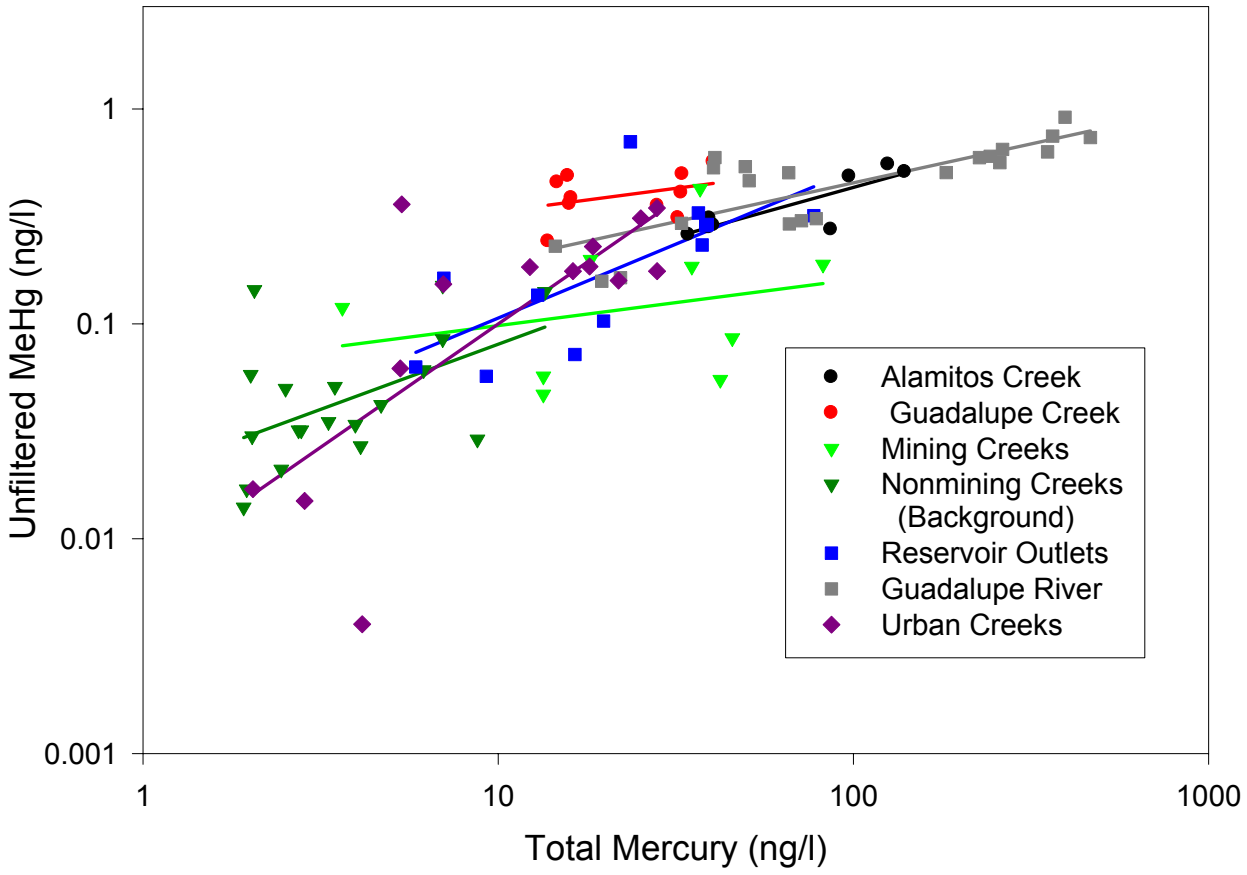


Figure 8-6. Relating total mercury and methylmercury in different groups of water bodies in the Guadalupe River Watershed. The water body groups are identified in Table 8-1.

Table 8-3. Intercepts, slopes, and correlation coefficients for the regressions between total mercury and dissolved mercury for different water body groups.

Water Body Group	Intercept*	Slope*	r^2
Alamitos Creek	0.54	0.31	0.61
Guadalupe Creek	0.53	0.05	0.09
Mining Creeks	0.03	0.68	0.73
Background Creeks	-0.053	0.34	0.15
Reservoir Outlets	-0.07	0.5	0.59
Guadalupe River	-0.32	0.61	0.69
Urban Creeks	-0.37	0.96	0.77

*Slope and intercept are based on regressions of log(Total Hg) and log(Dissolved Hg)

Table 8-4. Intercepts, slopes, and correlation coefficients for the regressions between total mercury and methylmercury for different water body groups.

Water Body Group	Intercept*	Slope*	r^2
Alamitos Creek	-1.28	0.46	0.72
Guadalupe Creek	-0.69	0.22	0.13
Mining Creeks	-1.22	0.21	0.07
Background Creeks	-1.7	0.61	0.26
Reservoir Outlets	-1.65	0.69	0.48
Guadalupe River	-1.07	0.36	0.65
Urban Creeks	-2.14	1.15	0.56

*Slope and intercept are based on regressions of log(Total Hg) and log(MeHg)

8.4 CALCULATING DAILY FLOWS

For locations within the watershed that had flow recording devices, it was easy to obtain continuous flow data for the October 2003 to May 2004 period from the SCVWD ALERT system (http://alert.valleywater.org/). This was done for flow gages at the outlets of the four major reservoirs (Almaden, Calero, Guadalupe, and Lexington), and for Ross Creek, Los Gatos Creek, Canoas Creek, and the main stem of the Guadalupe River.

For much of the upper watershed, no gaged flow data were available. In this situation, flow characteristics were obtained with the help of hydrologic modeling detailed in the previous chapter. The modeling provided an estimate of the volume of outflow for each day of the wet season as a percentage of the volume of precipitation. Five model watersheds were used to understand the outflow characteristics in each subwatershed, one creek each that flowed into Almaden, Calero, Guadalupe, and Lexington Reservoirs, and one representing the Alamitos and Guadalupe Creek Watersheds (Golf Creek). These relationships were used to scale up from small watersheds to larger watersheds, and were used to compute flows at various points in the study area.

An exception to this general approach was the gage just downstream of the fish ladder on Guadalupe River, which provided useful values only when the fish ladder was not spilling (i.e., when flows were less than 57.2 cfs). This gage is located just below the confluence of Guadalupe Creek and Alamitos Creek on Guadalupe River. For days when the fish ladder was not spilling, the Guadalupe River flows at this location were attributed to Guadalupe Creek and Alamitos Creek in proportion to their respective subwatershed areas. For days when the fish ladder was spilling and total flows were not measured--there were 3 such days in the 2003-2004 wet season--flows were estimated from the hydrologic model.

8.5 ESTIMATING NON-POINT MERCURY LOADS

Using representative subwatersheds that were affected principally by one type of mercury source, we estimated the areal contribution of background, historic mines, and urban areas. These loads were expressed in units of $\mu g/m^2$ over the wet season. Because these loads are transported in runoff, it is expected that the dry season contributions will be negligible.

Soda Spring in the watershed of Lexington Reservoir was used to estimate the background load. The watershed for this creek has practically no development and no mercury mines. Wet weather daily flows were estimated from the hydrologic model described in the previous chapter. Using the flow estimates, TSS, total mercury, methylmercury, and dissolved mercury concentrations in flowing water was estimated from regressions for the non-mining creeks in the upper watershed. Loads were estimated from the flows and concentrations, and were found to be 1.16 $\mu g/m^2$ for total mercury, 0.33 $\mu g/m^2$ for dissolved mercury, 0.012 $\mu g/m^2$ for methylmercury over the wet season. This background load consists of wet and dry deposition, transport of past dry deposition, and loads from the erosion of natural geologic materials of the area. Given the data, however, it is not possible to decompose the total background loads into these specific constituents. The rainfall received in the vicinity of Lexington reservoir was 30 inches over October 2003 to May 2004. When these background loading rates were applied to other parts of the Guadalupe Watershed, which had more or less rain, they were scaled proportionally to amount of rainfall. This is because of the transport of these background loads occurs via runoff, which is expected to be roughly proportional to rainfall.

North Los Capitancillos Creek was used to estimate the load from historic mining areas. The watershed for this creek is almost entirely within Almaden Quicksilver County Park, the area with significant historic mining activity. Wet weather daily flows were estimated from the hydrologic model described in the previous chapter. Using the flow estimates, TSS, total mercury, methylmercury, and dissolved mercury concentrations in flowing water was estimated from regressions for the mining creeks in the upper watershed. Loads were estimated from the flows and concentrations, and were found to be 54.5 $\mu g/m^2$ for total mercury, 14.8 $\mu g/m^2$ for dissolved mercury, 0.11 $\mu g/m^2$ for methylmercury over the wet season. These loads are more than 40 times greater than the background for total and dissolved mercury, and about 10 times greater than background for methylmercury. It should be pointed out, however, that concentrations observed at the North Los Capitancillos Creek station were not the highest among those observed for all the mining creeks. It is indicative of an average value for all the mine areas, although it is possible that the mine loading rates are significantly higher from certain locations within the Almaden Quicksilver County Park.

The watershed for Ross Creek was used to estimate the load from urban areas. The watershed for this creek is almost entirely urbanized with no mining activity. Wet weather daily flows were obtained from the flow gage near the downstream end of the

creek. Using the flow data, TSS, total mercury, methylmercury, and dissolved mercury concentrations in flowing water was estimated from regressions for the urban creeks. Loads were estimated from the flows and concentrations, and were found to be 1.6 $\mu g/m^2$ for total mercury, 0.61 $\mu g/m^2$ for dissolved mercury, 0.02 $\mu g/m^2$ for methylmercury over the wet season. The rainfall in the vicinity of the Ross Creek Watershed was 12.9 inches in 2003-2004. The loads are considerably higher than the background loads, especially when those loads are scaled to the lower rainfall in this watershed. These loads are also roughly an order of magnitude lower than the historic mine loads.

8.6 LOADS TO RESERVOIRS

Based on the watershed area for each reservoir, and the fraction of the area that was comprised of either undeveloped land or historic mines, loads were added according to the values obtained in Section 8.5. An exception was made for Calero Reservoir, which in addition to watershed loads, also receives occasional flows from Almaden Reservoir and from the Central Valley Project. Wet weather flows from Almaden Reservoir were estimated to average 7.5 cfs during the wet season, based on SCVWD data for 2001 and 2002. This average flow was multiplied by the average concentration measured at the outlet of the Almaden-Calero Canal to obtain an estimate of the load from Almaden Reservoir. The Central Valley Project water flows to Calero Reservoir are zero during the wet weather months for the past several years, and this load was set to zero.

8.7 RESERVOIR LOADS TO DOWNSTREAM CREEKS

Because reservoirs contain a substantial amount of storage, and because their outflows are controlled, it is thought that mercury concentrations in their outlets are less variable than in creeks, especially during the wet season. For this reason, the reservoir loads were computed in a manner simpler than that applied to streams: outflows were multiplied by the average mercury concentrations obtained in the wet weather sampling.

8.8 CALCULATING TRANSPORTED LOADS THROUGHOUT THE WATERSHED

Using the approach described in preceding sections, we computed the loads across the entire watershed, identifying inflow and outflow loads from each major water body. When the inflows originated on land, they were estimated from land-based estimates in Section 8.5, and using GIS-based information on the distribution of land uses within the appropriate subwatershed. Reservoir loads were estimated as described in Section 8.6. The outflow loads were calculated based on the flow (either modeled or gaged), and using the relevant correlations for TSS, total mercury, dissolved mercury, and methylmercury. Thus, for Canoas Creek, the outflows were calculated using correlations for urban creeks. Loads were identified separately for total and dissolved mercury, and for methylmercury. It should be noted that the total mercury loads include the estimates of dissolved and methylmercury.

Mercury loads for individual water bodies are shown in Table 8-5 and in graphical form in Figures 8-7 to 8-9.

For total mercury loads, shown in Figure 8-7, all reservoir outflows appear to be of roughly the same magnitude except Calero Reservoir. Although concentrations flowing out of Lexington Reservoir are lower than from Guadalupe and Almaden Reservoirs, this is compensated by the substantially larger volume of outflows. Further downstream, the largest loads to Guadalupe River originate from Alamitos Creek, followed by Los Gatos and Guadalupe Creek. Alamitos Creek loads, upstream of Calero Creek, are substantially higher than Almaden Reservoir outflow loads, indicating the mobilization of internal sediment loads. Although Los Gatos Creek does not contain any mines, the relatively high loads are a consequence of its larger watershed compared to Guadalupe Creek. The loads exiting Guadalupe River to San Francisco Bay are far higher than the total loads entering from all the tributary creeks and from its watershed. This is a strong indication of the mobilization of internal sediment loads.

For dissolved mercury loads, shown in Figure 8-8, Lexington reservoir appears to be the largest contributor, driven by higher flow volumes, followed by Guadalupe and Almaden Reservoir at somewhat lower levels, with Calero Reservoir being the lowest. Further downstream, the largest dissolved mercury loads to Guadalupe River originate from Los Gatos Creek, followed by Canoas and Ross Creek. Alamitos Creek and Guadalupe Creek, despite the presence of mine wastes, are a relatively small source of dissolved mercury, with much of their mercury being in the particulate form. The dissolved mercury loads exiting Guadalupe River to San Francisco Bay are somewhat higher than the total loads entering from all the tributary creeks and from its watershed. This trend is not as strong as for total mercury discussed above, but nonetheless is an indicator of an internal source, i.e., dissolution of sediments.

For methylmercury loads, shown in Figure 8-9, Guadalupe Reservoir is the largest contributor, followed by Lexington and Almaden Reservoirs at somewhat lower levels, with Calero Reservoir being the lowest. Further downstream, with the exception of Alamitos Creek, the methylmercury loads to Guadalupe River from the different creeks are not too dissimilar, indicating that even small amounts of total mercury, as in Canoas Creek for example, can produce enough methylmercury if the right aquatic chemistry conditions are present. As with total mercury and dissolved mercury, the methylmercury loads exiting Guadalupe River to San Francisco Bay are somewhat higher than the total loads entering from all the tributary creeks and from its watershed. This pattern is similar to that noted for dissolved mercury, as discussed above.

Table 8-5.
Mercury Loads in Guadalupe River Watershed
(in grams over the wet season, 10/1/2003 to 5/31/2004)

Guadalupe Reservoir

	Loads In		Total Inflows	Loads to Guadalupe Creek
	Background	Historic Mines		
Total Hg	19.9	222.0	**241.9**	**149.2**
Dissolved Hg	0.4	60.2	**60.6**	**17.6**
Methyl Hg	0.0	0.4	**0.4**	**1.4**

Almaden Reservoir

	Loads In		Total Inflows	Loads to Alamitos Creek (Upper)
	Background	Historic Mines		
Total Hg	27.5	190.3	**217.8**	**111.8**
Dissolved Hg	7.8	51.6	**59.5**	**17.2**
Methyl Hg	0.3	0.4	**0.6**	**0.8**

Calero Reservoir

	Loads In			Total Inflows	Loads to Calero Creek
	Background	Almaden-Calero Canal	Central Valley Project		
Total Hg	13.9	190.2	0	**204.1**	**27.7**
Dissolved Hg	4.0	24.2	0	**28.1**	**9.0**
Methyl Hg	0.1	0.8	0	**1.0**	**0.3**

Lexington Reservoir

	Loads In	Total Inflows	Loads to Los Gatos Creek
	Background		
Total Hg	112.0	**112.0**	**141.0**
Dissolved Hg	31.9	**31.9**	**25.1**
Methyl Hg	1.1	**1.1**	**0.9**

Table 8-5. (continued)
Mercury Loads in Guadalupe River Watershed
(in grams over the wet season, 10/1/2003 to 5/31/2004)

Los Gatos Creek

	Loads In			Total Inflows	Loads to Guadalupe River
	Background	Urban	Lexington Reservoir		
Total Hg	23.7	42.6	141.0	**207.2**	**108.6**
Dissolved Hg	6.6	18.1	25.1	**49.8**	**41.6**
Methyl Hg	0.2	0.6	0.9	**1.7**	**1.1**

Ross Creek

	Loads In		Total Inflows	Loads to Guadalupe River
	Background	Urban		
Total Hg	13.1	28.1	**41.2**	**56.4**
Dissolved Hg	3.6	12.0	**15.6**	**21.7**
Methyl Hg	0.1	0.4	**0.5**	**0.6**

Canoas Creek

	Loads In		Total Inflows	Loads to Guadalupe River
	Background	Urban		
Total Hg	24.6	43.7	**68.3**	**113.5**
Dissolved Hg	6.9	18.6	**25.4**	**43.5**
Methyl Hg	0.3	0.6	**0.8**	**1.2**

Calero Creek

	Loads In			Total Inflows	Loads to Alamitos Creek
	Background	Urban	Calero Reservoir		
Total Hg	10.3	2.4	27.7	**40.4**	**18.0**
Dissolved Hg	2.9	1.1	9.0	**13.0**	**6.5**
Methyl Hg	0.1	0.0	0.3	**0.4**	**0.2**

Table 8-5. (continued)
Mercury Loads in Guadalupe River Watershed
(in grams over the wet season, 10/1/2003 to 5/31/2004)

Alamitos Creek (up to confluence with Calero Creek)

	Loads In			Total Inflows	Loads to Alamitos Creek
	Background	Urban	Almaden Reservoir		
Total Hg	9.6	1.7	111.8	**123.1**	**515.3**
Dissolved Hg	2.7	0.9	17.2	**20.7**	**5.7**
Methyl Hg	0.1	0.0	0.8	**1.0**	**2.1**

Alamitos Creek (below confluence with Calero Creek)

	Loads In				Total Inflows	Loads to Guadalupe River
	Background	Urban	Upper Alamitos Creek	Calero Creek		
Total Hg	12.7	17.3	515.3	18.0	**563.3**	**409.1**
Dissolved Hg	3.6	7.3	5.7	6.5	**23.1**	**5.5**
Methyl Hg	0.1	0.2	2.1	0.2	**2.7**	**2.0**

Guadalupe Creek

	Loads In			Total Inflows	Loads to Guadalupe River
	Background	Urban	Guadalupe Reservoir		
Total Hg	11.7	6.3	149.2	**167.2**	**58.1**
Dissolved Hg	3.3	2.7	17.6	**23.6**	**0.9**
Methyl Hg	0.1	0.1	1.4	**1.6**	**1.0**

Guadalupe River

	Loads In							Total Inflows	Loads to San Francisco Bay
	Background	Urban	Guadalupe Creek	Alamitos Creek	Ross Creek	Los Gatos Creek	Canoas Creek		
Total Hg	40.5	88.9	58.1	355.4	56.4	108.6	113.5	**821.4**	**9956.3**
Dissolved Hg	11.3	37.6	0.9	5.3	21.7	41.6	43.5	**161.9**	**590.1**
Methyl Hg	0.4	1.2	1.0	1.9	0.6	1.1	1.2	**7.5**	**26.7**

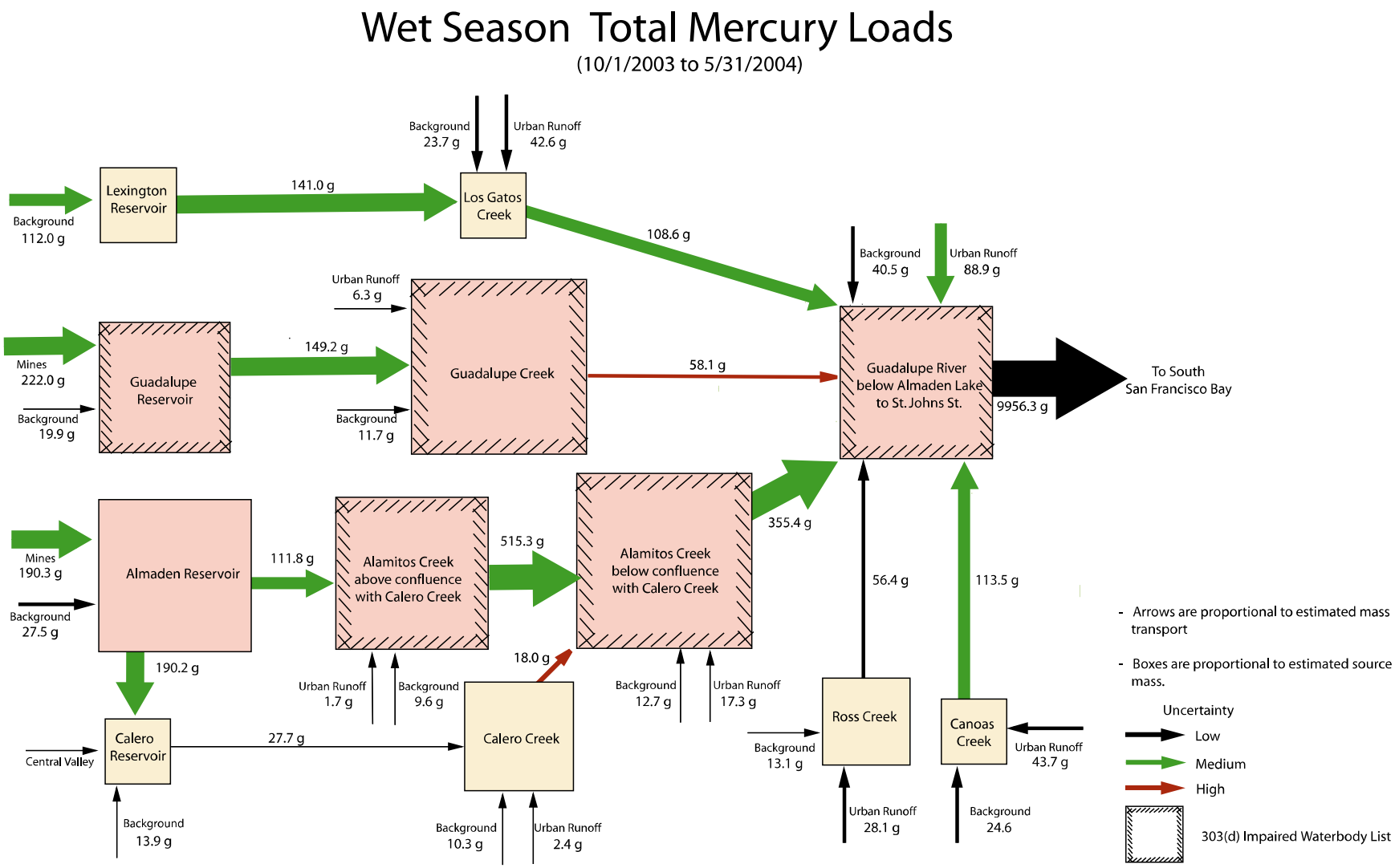


Figure 8-7. Graphical depiction of total mercury pathways through the Guadalupe River Watershed. All loads are in grams.

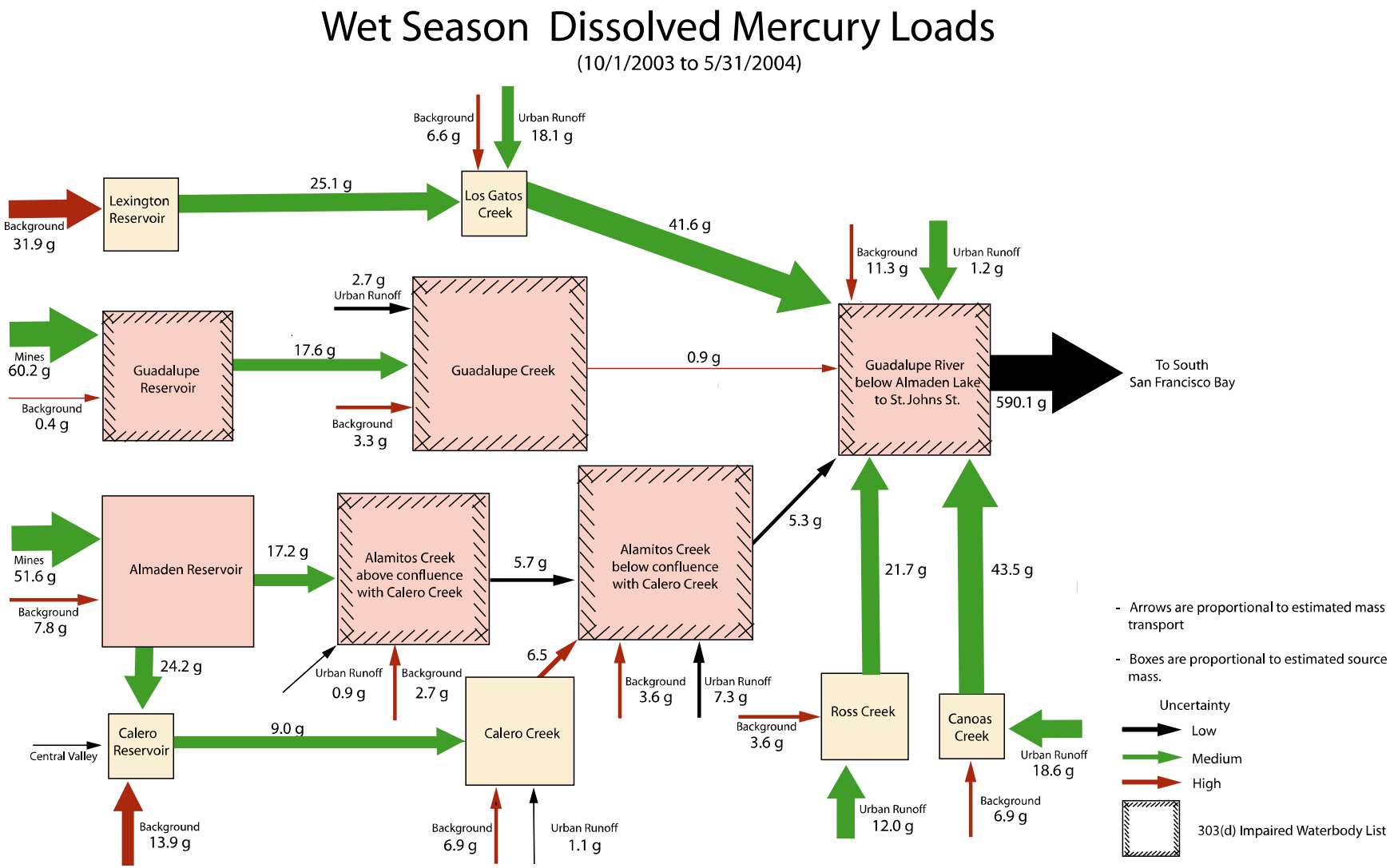


Figure 8-8. Graphical depiction of dissolved mercury pathways through the Guadalupe River Watershed. All loads are in grams.

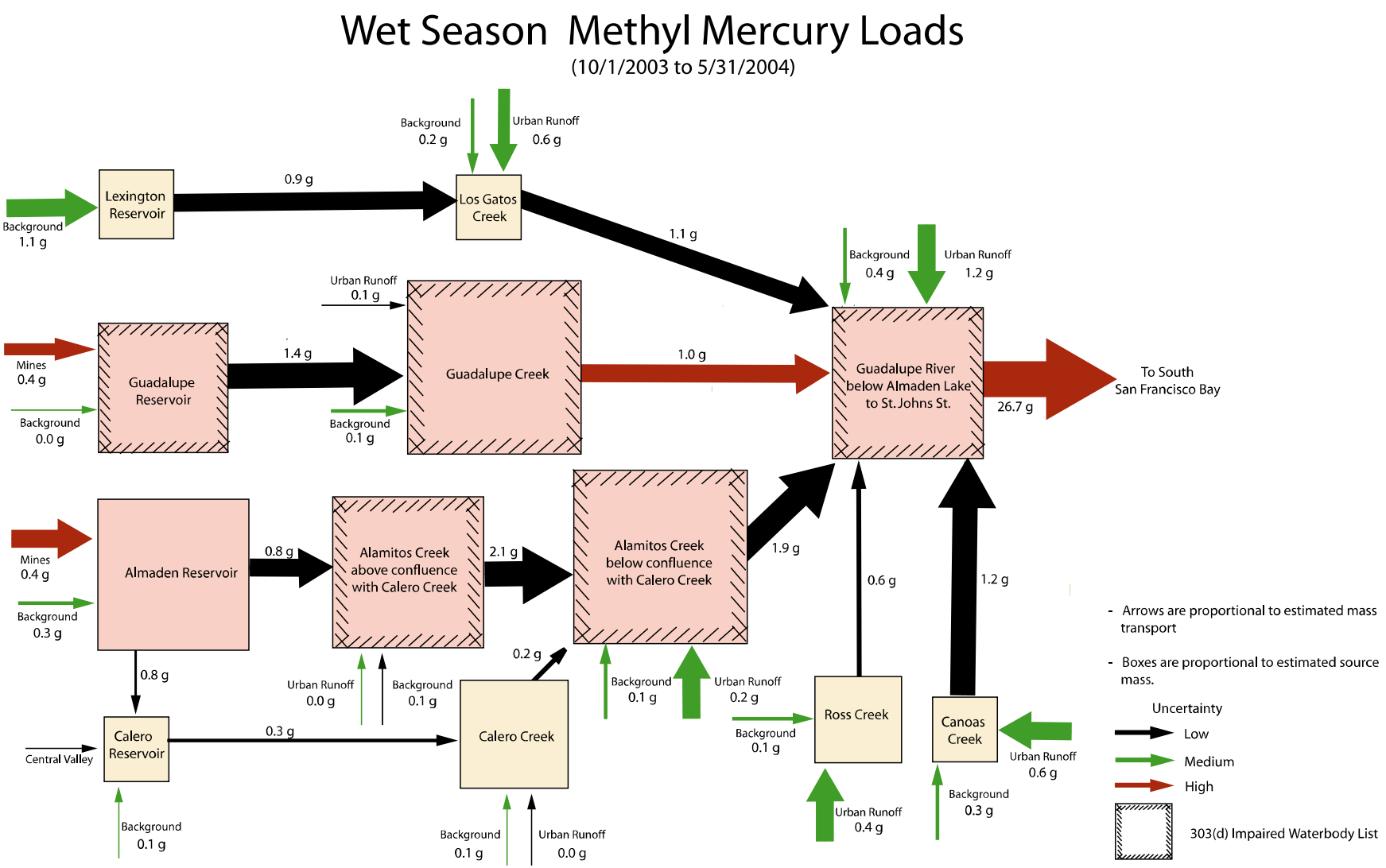


Figure 8-9. Graphical depiction of methylmercury pathways through the Guadalupe River Watershed. All loads are in grams.

8.9 UNCERTAINTY ANALYSIS

Given that the relationships between flow and TSS, and between TSS and total mercury are noisy, it is expected that there is uncertainty associated with the loads estimated for the 2003-2004 wet season in Table 8-5. We sought to quantify this uncertainty by accounting for the residual error in the regressions using Monte Carlo Analysis. Instead of obtaining a deterministic, single-point answer, for example, a specific value of mercury load to San Francisco Bay of 9956 g, as reported in Table 8-5, the Monte Carlo approach is used to estimate likely ranges of answers, given imperfect knowledge about the needed inputs. This is done by assuming probability distributions for the key inputs, and performing the load calculations multiple times where values of inputs are drawn from a specified probability distribution. Each Monte Carlo trial results in an estimate of the load. When this process is repeated several times (typically several hundred or thousand times), one obtains a distribution of the loads that is consistent with the uncertainty in input parameters. The Monte Carlo approach is widely used in the environmental sciences where uncertainty in inputs is very common.

For the specific case of developing the uncertainty-based load estimates of mercury for the Guadalupe River Watershed, where flows are related to TSS, and the TSS to mercury concentrations, we need a method that, given a specific value of flow, provides a probabilistic estimate of TSS, and a probabilistic estimate of the total mercury concentrations. These can be used to generate a probabilistic estimate of the mercury load, and, if the process is repeated a large number of times, can provide a distribution of the load. The statistical approach for doing this is to assume that the linear regression models, shown in Tables 7-2, 7-3, and 7-4 are expressed as $y = \alpha + \beta x$, where y is the dependent variable and x is the independent variable, and α and β are the intercept and slope. Using N pairs of observed data (X_i, Y_i), a least-squared error estimator was used to determine α and β. Our goal is to develop a Monte Carlo procedure that will generate random values of the dependent variable y for specified values of the independent variable x. The variance of the model error will be computed using the N data samples. An unbiased variance estimator s_m^2 is computed (Bhattacharyya and Johnson, 1977, pages 341-357) as follows:

$$s_m^2 = \frac{SSE}{(N-2)}$$

where *SSE* is the residual sum of squares using *N* data pairs (X_i, Y_i):

$$SSE = \sum_{i=1}^{N} (Y_i - \alpha - \beta X_i)^2 .$$

The Monte Carlo algorithm generates random deviates of the linear model by assuming the dependent y variable of the model has Gaussian distribution

$N(\mu_y, \sigma_y)$. The variance of the dependent y variable is assumed to be the same for any value of the independent variable x. The j[th] deviate y_j of the dependent variable can be generated for the specified dependent value x^* as follows:

$$y^* = \alpha + \beta x^*$$
$$y_j \in N(y^*, s_m).$$

This approach was implemented in Microsoft Excel, using the Crystal Ball program. Crystal Ball is a specialized simulation tool for performing Monte Carlo simulations.

The load of total mercury being transported out of the Guadalupe Watershed into San Francisco Bay was used for the uncertainty analysis. The Monte Carlo estimate of wet weather loads was computed using the following steps:

1) The flows, obtained from the USGS flow gage in the downstream portion of the Guadalupe River, were assumed to be accurately known, i.e., there was no uncertainty associated with them.
2) For a specific day, the flow rate was used to obtain a probabilistic estimate of the TSS using the regression equation for the River stations shown in Figure 8-2, and using the statistical approach above.
3) Using the probabilistic estimate of TSS, a similar probabilistic estimate was obtained for total mercury concentration using the correlation for the River stations in Table 8-3.
4) Multiplying the flow and mercury concentration for each day provided an estimate of the daily load
5) The entire wet weather load was calculated by summing the daily loads from 10/1/2003 to 5/31/2004.
6) Steps 1) through 5) were repeated 1,000 times to obtain a distribution of the wet weather load.

The distribution of wet season loads for 2003-2004 is shown in Figure 8-10. The distribution shows a somewhat skewed bell curve, with a longer tail on the right-hand side than on the left-hand side, as a consequence of some of the variables being log-transformed in the regressions. Total loads range from approximately 8 to 20 kg. The mid-point of the distribution is about 12 kg.

Although loads for a given year are uncertain, we also know that there is significant year-to-year variability in the flows out of the Guadalupe Watershed. This is shown in Figure 8-11 using historical USGS data flow data for the last 5 decades. Because flows and mercury loads are related, it is likely that multi-year uncertainty will be significantly greater than the single-year uncertainty estimate shown in Figure 8-10. To assess the multi-year uncertainty, we performed a Monte Carlo analysis using daily average flows from 1960-2002, where a single year over this period was randomly sampled to compute total wet weather loads from October through May. The distribution of loads for the multi-year analysis is shown in Figure 8-12. It can

be seen that the multi year uncertainty is considerably greater than the single year uncertainty, with values ranging from near zero for the extremely low flow years to almost 100 kg for the high flow years. Although this is not an unexpected result, the Monte Carlo analysis permits quantification of the process, and can be used to relate individual-year loads, and potential load reductions, to the overall distribution of loads.

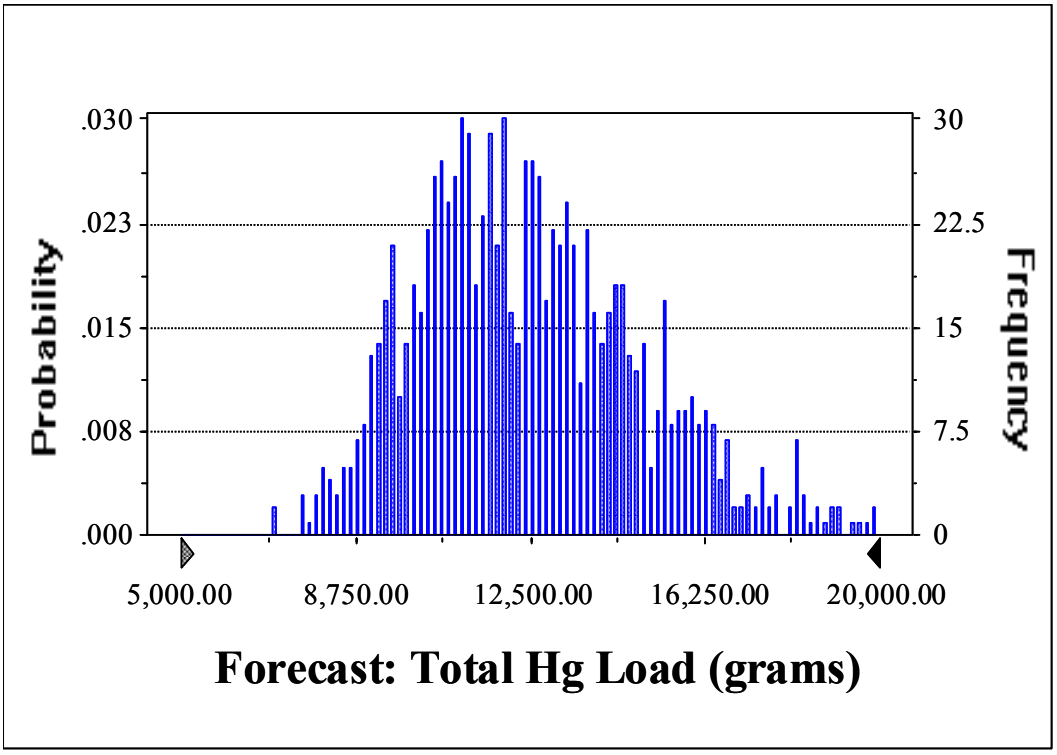


Figure 8-10. Uncertainty in the single-year estimate (2003-2004 wet season) of total mercury loads from Guadalupe River to South San Francisco Bay. The calculations were obtained using the uncertainty in the flow-TSS and the TSS-total Hg relationships using a Monte Carlo simulation with 1000 trials. The average estimated wet weather load for 2003-2004 is about 10 kg.

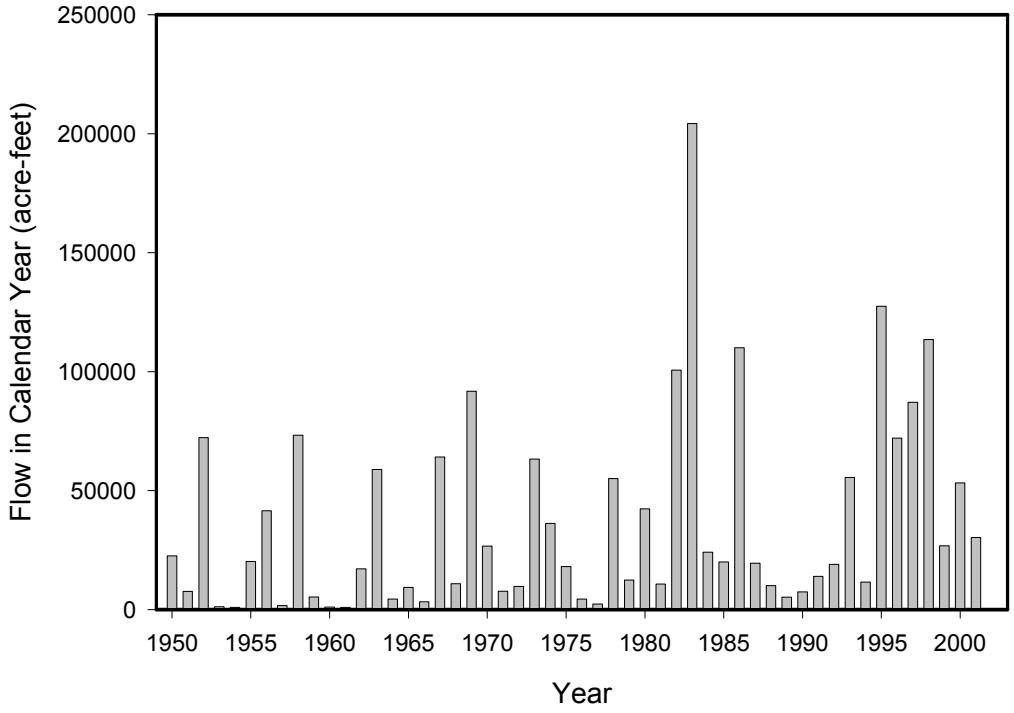


Figure 8-11. Year-to-year variability in total wet weather outflows from the Guadalupe River Watershed, based on the USGS gage station just below the confluence of Guadalupe River and Los Gatos Creek. Note that there is an increase in total outflows possibly as a result of greater urbanization.

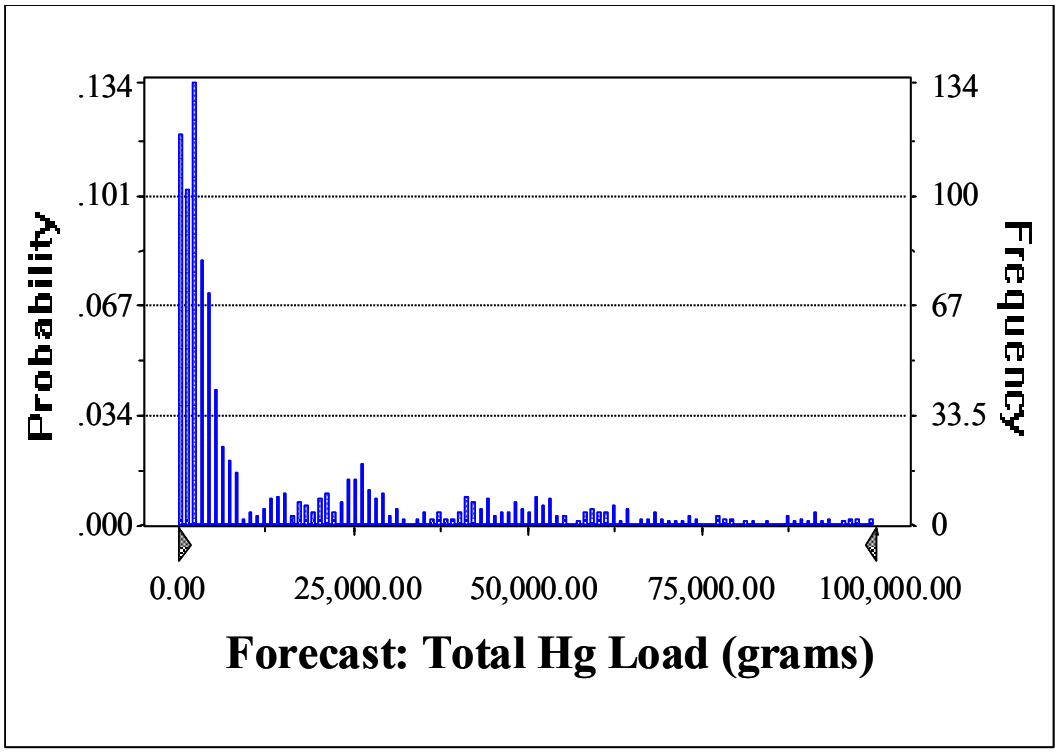


Figure 8-12. Uncertainty in the multi-year estimate (1960-2002 wet seasons) of total mercury loads from Guadalupe River to South San Francisco Bay. The calculations were obtained using the uncertainty in the flow-TSS and the TSS-total Hg relationships and using a Monte Carlo simulation with 1000 trials. The distribution of loads is much wider than for the single year estimate, driven by the large year-to-year variability in flows shown in Figure 8-11.

8.10 CONCLUSIONS

The wet weather survey of mercury concentrations and associated parameters was found to be appropriate to develop an understanding of the transport of mercury through the Guadalupe watershed, and helped to identify the most important load sources of total mercury with a reasonable degree of confidence. Alamitos Creek upstream of Calero Creek was found to be a major contributor of total mercury loads. An important finding from the analysis of loads is that the total outflows from the downstream end of Guadalupe River far exceed the inputs from all the tributary creeks and the urban watershed of Guadalupe River. This is explained by the presence of an internal source, especially during high flows: erosion of river and bank sediments with elevated mercury concentrations. The accumulation of these sediments along river channels relates to post-mining, but pre-reservoir construction, flows in the watershed. The data collected and analyzed also provides an estimate of the relative contribution of mining, urban, and background loads to different water bodies. Background loads may be significant in some cases, especially when the

watersheds in question are large, as for Los Gatos Creek. Using correlations between total mercury and dissolved mercury, and between total mercury and methylmercury, for different water body groups, we were also able to paint a picture of the movement of these constituents. These contributions were substantially different from the total load contributions, with the urban creeks being major sources of both dissolved and methylmercury.

It should be pointed out that flows, and consequently sediment and pollutant loads, in a steep and urbanized watershed such as this are inherently highly variable, and there is a considerable degree of uncertainty in the estimate of total loads that are transported from Guadalupe Watershed to South San Francisco Bay. To address this issue, we performed a quantitative analysis of the uncertainty of mercury loads flowing to San Francisco Bay in the past year, and in any year. These total mercury loads are part of a separate TMDL for San Francisco Bay, and the uncertainty that we have estimated should be considered in the load allocations, and also in future monitoring to detect reduction in mercury loads.

Given the complexity of the watershed, including the man-made changes in it, a cohesive picture of mercury movements was obtained from a relatively small number of stations sampled on a limited number of dates. Although it is likely that the mercury data set from this watershed will grow over time, and that the accuracy of the estimated loads will improve, the information presented to date provides a solid foundation to focus on specific areas of greatest promise for overall mercury load reductions.

9.0 RECOMMENDATIONS FROM THE WET WEATHER SAMPLING

The load estimate calculations show that some of the waterbodies within the Guadalupe River Watershed, notably Alamitos Creek and Guadalupe River, export greater amounts of mercury than flows into them from upstream sources and from their watersheds. This is a strong indication of an internal load, most likely through the resuspension of channel and bank sediments during high flows. It follows therefore, that a promising option for decreasing the mercury load transported downstream is the removal of mercury rich sediments from flow channels of these water bodies and improved erosion control along the banks. This is an ongoing activity at several locations in the watershed, and its potential benefits are supported by our data collection, especially when the sediment removal targets high mercury concentration areas.

Significant changes are being made to the channel of the Guadalupe River in San Jose as this report is written, and it is expected that these changes will impact downstream mercury load transport. With the implementation of these changes the historical sediment and mercury concentration data from this location may be less applicable for load calculations. Given the significance of mercury loads from the Guadalupe River Watershed to San Francisco Bay, continued monitoring of flows, suspended solids, and mercury (both total and speciated) is strongly recommended. In addition, wet season monitoring of selected large and small storm drains into the river is recommended to improve estimates of the urban load. Flow, turbidity, suspended solids, and mercury species should be measured for a range of rainfall events.

Two of the major creeks draining the historic mining district (Alamitos and Guadalupe Creeks) are not gauged, and load estimates from these creeks were based on estimates using a limited amount of flow and suspended sediment data. Because these creeks are considered to be important sources of mercury downstream, it is important that there be improved data collection at both these creeks, upstream of

their confluence with Guadalupe River. In addition to flow data, the continuous measurement of turbidity, to relate to suspended solids, is also recommended.

The concentrations of mercury measured in the Almaden-Calero Canal were significantly higher than had previously been assumed for the calculations in the Conceptual Model Report (Tetra Tech, 2003). These concentrations may explain the elevated mercury concentrations observed in Calero Reservoir in the absence of mercury mines in its watershed. However, this estimate is based on a limited number of samples. Before any decisions are made on the management of mercury in this reservoir, it is recommended that the mercury dataset in the canal be expanded.

Sampling of high flow events during the wet months of 2004 was constrained by the limited number of large storm events in the watershed. This was especially true in the upper part of the watershed, upstream of the reservoirs, and upstream of the confluence of Alamitos and Guadalupe Creek with Guadalupe River. It is recommended that additional data collected during future storm events be used to supplement the existing database and improve the accuracy of the load calculations.

The new information generated by the wet season sampling and the summer reservoir sampling should be incorporated into the Draft Final Conceptual Model for the Guadalupe Watershed (Tetra Tech, 2004b). Tetra Tech recommends that a Final Conceptual Model Report be prepared. This report would address findings of the Data Collection Report in more detail, e.g. separating atmospheric deposition and runoff into its components such as the global background contribution, litterfall, and evasion from mercury-bearing wastes, soils, and waterbodies. Chemical analyses of litterfall for mercury are underway and could be incorporated into the Final Conceptual Model Report. This new information could be used to determine the relative importance of factors such as evasion and litterfall in the area affected by mining to the mercury load from these subwatersheds. The results of the summer sampling of the reservoirs and reservoir outlets would also be incorporated into the Final Conceptual Model Report. These new data could be used to evaluate factors such as photodemethylation that is less important in the wet season. The Final Conceptual Model Report would also incorporate new 2004 results from continued monitoring of the river and creeks underway by others.

10.0 REFERENCES

ALERT Data System, 2003. On-line Retrieval System of the Santa Clara Valley Water District. (http://alert/valleywater.org)

Bhattacharyya, Gouri and Richard Johnson. 1977. Statistical Concepts and Methods. John Wiley & Sons, New York, 639 pages.

Bloom, NS, 1994. "Influence of Analytical conditions on the Observed Reactive Mercury Concentrations in Natural Freshwaters". Proceedings of the 2nd International Conference on Mercury as an Environmental Pollutant (Lewis Publishers, Boca Raton, Florida. Pp. 541-552).

Bloom, NS, E Preus, J Katon, and M Hittner, 2003. Selective extractions to assess the biogeochemically relevant fractionation of inorganic mercury in sediment and soils. Analytica Clinica Acta 479 (233-278).

Bloom, NS, E. Preus, J Katon, and M. Hiltner, 2003. Selective Extractions to assess the biogeochemically relevant fractionation of inorganic mercury in sediments and soils. Analy. Chim. Acta, 479: 233-248.

Conaway, C.H., E.B. Watson, J.R. Flanders and A. R. Flegal. 2003. Report on Mercury Deposition in a Tidal Marsh Downstream of the Historic New Almaden Mining District, California. San Francisco Bay Regional Water Quality Control Board.

Light, Air, & Space Construction (LAS), 2003. Water and Sediment Sampling at Almaden Reservoir and outlet. Prepared for the Santa Clara Valley Water District.

McKee, L., J. Leatherbarrow, R.Eads, and L. Freeman, 2004. Concentrations and Loads of PCBs, OC Pesticides, and Mercury Associated with Suspended Particles in the Lower Guadalupe River, San Jose, California. San Francisco Estuary Institute (SFEI). Contribution #86

Neitsch, S. and M. DiLuzio. 1999. ArcView Interface for SWAT 99.2, User's Guide. Blackland Research Center, Texas Agricultural Research Station, Temple, TX.

Neitsch, S., J.G. Arnold, J.R. Kiniry, and J.R. Williams. 2001. Soil and Water Assessment Tool, User's Manual, Version 2000. USDA Agricultural Research Service, Blackland, TX. Available online at http://www.brc.tamus.edu/swat/swat2000doc.html.

Santa Clara County Parks and Recreation Departments (SCCPRD). 2003. Annual Report for Stormwater Discharges. Almaden Quicksilver County Park.

Tetra Tech. 2000. Guadalupe Creek Mercury Sampling Results. Prepared for Santa Clara Valley Water District.

Tetra Tech. 2001. Guadalupe Creek Wet-Weather Sampling Results. Prepared for Santa Clara Valley Water District.

Tetra Tech. 2003a. Technical Memorandum 2.2 Synoptic Survey Report. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. September 8, 2003.

Tetra Tech. 2003b. Technical Memorandum 4.1 Draft Conceptual Model. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. October 2, 2003.

Tetra Tech. 2003c. Technical Memorandum 2.1.2 Synoptic Survey Plan. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. July 30, 2003.

Tetra Tech. 2003d. Technical Memorandum 4.1 Draft Conceptual Model. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. October 2, 2003.

Tetra Tech, 2003e. Technical Memorandum 7.4.2 Quality Assurance Plan. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District.

Tetra Tech, 2004a. Technical Memorandum 5.2.3 Data Collection Plan. Prepared for Santa Clara Valley Water District. February 20, 2004.

Tetra Tech, 2004b. Technical Memorandum 4.3 Draft Final Conceptual Model Reort. Prepared for Santa Clara Valley Water District. June 7, 2004

Thomas, M.A, C.H. Conway, D.J. Steding, M. Marvin-DiPasquale, K.E. Abu-Saba and A.R. Flegal. 2002. Mercury Contamination from Historic Mining in Water and

Sediment, Guadalupe River and San Francisco Bay, California. Geochemistry: Exploration, Environment, and Analysis. 2: 1-7.

U.S. EPA. 2001. Better Assessment Science Integrating Point and Nonpoint Sources, BASINS Version 3.0., User's Manual. EPA-823-B-01-001. Office of Water, U.S. Environmental Protection Agency. Available online at http://www.epa.gov/waterscience/basins/bsnsdocs.html.

US Army Corps of Engineers (ACOE), 2004. Final Guadalupe River Project Mercury Monitoring Report Downtown San Jose, California.

APPENDIX A SAMPLING LOCATIONS

Station ID	Station Name	Date	Time	Latitude	Longitude	Media Type
E1-7S	Mine Hill Tributary to Jacques Gulch	3/2/2004	15:30	37.16406667	-121.84665	Sediment
E1-9S	N. Los Capitancillos Creek	3/3/2004	9:55	37.18531667	-121.8707833	Sediment
E2-13SA	Gravel bar on Alamitos Ck.at Confluence with Almaden Lake	3/3/2004	12:34	37.23855	-121.8710833	Sediment
E2-13SG	Gravel bar where Guadalupe Ck. Joins Alamitos Ck.	3/3/2004	13:15	37.24433333	-121.8726167	Sediment
E5-2	Guadalupe River below Almaden Drop Structure	3/8/2004	11:30	37.2473	-121.8698667	Sediment
E5-5	Guadalupe River at HWY 237	3/8/2004	13:05	37.41085	-121.9608833	Sediment
E5-1	Guadalupe River above Almaden Drop Structure	3/8/2004	10:15	37.24701667	-121.8703333	Sediment
E5-3	Guadalupe River at Blossom Hill Rd.	3/8/2004	11:07	37.25026667	-121.8704333	Sediment
E5-4	Guadalupe River at Highway 101	3/8/2004	15:10	37.37335	-121.9322333	Sediment
E2-19S	McAbee Creek below Senador Mine entrance to ACQP	4/23/2004	12:20	37.21503333	-121.8816667	Sediment
E1-1a	Almaden Reservoir Outlet	3/2/2004	12:00	37.16586667	-121.8284	Water
E1-1b	Almaden Reservoir Outlet	3/8/2004	14:00	37.16578333	-121.8283833	Water
E1-1c	Almaden Reservoir Outlet	4/14/2004	10:10	37.16578333	-121.8283833	Water
E1-2	Herbert Creek	3/2/2004	15:10	37.15596667	-121.8444667	Water
E1-3	Jacques Gulch above Mine Hill Tributary	3/2/2004	15:00	37.16425	-121.8496167	Water
E1-3	Jacques Gulch above Mine Hill Tributary	3/26/2004	9:30	37.16446667	-121.8507667	Water
E1-4	Barret Canyon	3/2/2004	15:35	37.15585	-121.8440667	Water
E1-5	Larrabee Gulch	3/2/2004	13:35	37.1585	-121.8295667	Water
E1-6	W. Tributary from Mine Hill to Reservoir	3/2/2004	14:30	37.16323333	-121.8402167	Water
E1-7a	Mine Hill Tributary to Jacques Gulch	3/2/2004	15:30	37.16406667	-121.84665	Water
E1-7b	Mine Hill Tributary to Jacques	3/26/2004	10:31	37.16403333	-121.8465833	Water

Station ID	Station Name	Date	Time	Latitude	Longitude	Media Type
	Gulch					
E1-8a	Guadalupe Reservoir Outlet	3/2/2004	13:35	37.19935	-121.8811167	Water
E1-8b	Guadalupe Reservoir Outlet	3/8/2004	14:50	37.19966667	-121.88075	Water
E1-8c	Guadalupe Reservoir Outlet	4/14/2004	9:18	37.19966667	-121.88075	Water
E1-9	N. Los Capitancillos Creek	3/26/2004	9:00	37.18536667	-121.8708333	Water
E1-9	N. Los Capitancillos Creek	3/3/2004	9:55	37.18531667	-121.8707833	Water
E1-10	Upper Guadalupe Creek	3/2/2004	14:15	37.18076667	-121.8736333	Water
E1-11	Rincon Creek	3/2/2004	13:55	37.18248333	-121.8736333	Water
E1-12a	Calero Reservoir Outlet	3/2/2004	9:55	37.18573333	-121.7931	Water
E1-12b	Calero Reservoir Outlet	3/8/2004	13:10	37.18553333	-121.7934	Water
E1-12c	Calero Reservoir Outlet	4/14/2004	9:15	37.18553333	-121.7934	Water
E1-13	Cherry Canyon	3/2/2004	9:25	37.17228333	-121.7926833	Water
E1-14	Pine Tree Canyon	3/2/2004	10:30	37.17693333	-121.7610333	Water
E1-15a	Inlet to Almaden-Calero Canal	3/2/2004	11:30	37.16738333	-121.8274333	Water
E1-15b	Inlet to Almaden-Calero Canal	3/3/2004	11:03	37.16545	-121.82815	Water
E1-16a	Outlet to Almaden-Calero Canal	3/2/2004	8:25	37.18045	-121.791	Water
E1-16b	Outlet to Almaden-Calero Canal	3/3/2004	11:34	37.18043333	-121.7907333	Water
E1-17a	Lexington Reservoir Outlet	3/2/2004	9:10	37.20416667	-121.99	Water
E1-17b	Lexington Reservoir Outlet	3/8/2004	9:45	37.2044	-121.99015	Water
E1-17c	Lexington Reservoir Outlet	4/20/2004	7:30	37.20428333	-121.9901667	Water
E1-18	Limekiln Canyon	3/2/2004	9:45	37.20106667	-121.9796333	Water
E1-19	Soda Spring	3/2/2004	10:15	37.18528333	-121.9782833	Water
E1-20a	Briggs Creek at CDF	3/2/2004	12:25	37.18201667	-121.9902333	Water
E1-20b	Briggs Creek at Bear Creek Road	3/8/2004	8:30	37.18521667	-122.0032	Water
E1-21	Upper Los Gatos Creek	3/2/2004	11:50	37.17071667	-121.9801833	Water
E1-22	Lyndon Canyon	3/2/2004	11:00	37.19501667	-122.0040333	Water
E2-1	Guadalupe Creek upstream of Cherry Springs Creek	4/14/2004	8:59	37.2047	-121.89605	Water
E2-2	Cherry Springs Creek	4/14/2004	8:48	37.20508333	-121.8968667	Water
E2-3	Pheasant Creek	4/14/2004	8:22	37.2134	-121.9124667	Water
E2-4	Shannon Creek	4/14/2004	7:58	37.22	-121.9238	Water
E2-5a	Guadalupe Creek @ Old Gauge	4/14/2004	7:37	37.21771667	-121.9103667	Water
E2-5b	Guadalupe Creek @ Old Gauge	4/20/2004	10:59	37.21778333	-121.9100833	Water
E2-6	Guadalupe Creek below Masson Dam	4/20/2004	7:45	37.2329	-121.8987167	Water
E2-6	Guadalupe Creek below Masson Dam	4/19/2004	12:30	37.23296667	-121.89865	Water
E2-7a	Guadalupe Creek above Almaden Expressway	3/8/2004	11:50	37.24363333	-121.8753	Water
E2-7b	Guadalupe Creek above Almaden Expwy	4/19/2004	10:50	37.24361667	-121.8751833	Water
E2-7	Guadalupe River above Almaden Expwy	4/20/2004	9:49	37.24363333	-121.8752167	Water
E2-8	Deep Gulch at previously-used site	3/26/2004	11:00	37.164	-121.84655	Water

Station ID	Station Name	Date	Time	Latitude	Longitude	Media Type
E2-9	Alamitos Creek @ Almaden Road Bridge near AQC Park	4/20/2004	13:30	37.17365	-121.8247167	Water
E2-10a	Alamitos Creek @ Harry Road	4/19/2004	14:29	37.20163333	-121.8293667	Water
E2-10b	Alamitos Creek @ Harry Road	4/20/2004	12:50	37.20125	-121.8289	Water
E2-11a	Alamitos Creek at Greystone Lane	4/19/2004	13:15	37.22243333	-121.8507333	Water
E2-11b	Alamitos Creek @ Greystone Lane	4/20/2004	12:20	37.22223333	-121.8508833	Water
E2-12a	Alamitos Creek above Almaden Lake	3/8/2004	12:25	37.23823333	-121.8711	Water
E2-12b	Alamitos Creek above Almaden Lake	4/19/2004	11:50	37.2383	-121.8711833	Water
E2-12c	Alamitos Creek above Almaden Lake	4/20/2004	10:31	37.23831667	-121.8711167	Water
E2-13a	Almaden Lake Outlet	4/19/2004	11:27	37.24435	-121.8723	Water
E2-13b	Almaden Lake Outlet	4/20/2004	10:09	37.24435	-121.8723	Water
E2-14	Golf Creek upstream of Alamitos Cr (below Camden Ave)	4/23/2004	1:00	37.22286667	-121.8742333	Water
E2-15	Greystone Creek upstream of Alamitos Creek	4/19/2004	13:35	37.22451667	-121.8581667	Water
E2-16	Randol Creek upstream of Alamitos Creek	4/19/2004	14:00	37.19828333	-121.84475	Water
E2-17	Santa Teresa Creek upstream of Calero Creek	4/14/2004	8:45	37.20913333	-121.8230167	Water
E2-18	Calero Creek @ Harry Road	4/14/2004	7:45	37.20661667	-121.8225667	Water
E3-1a	Ross Creek upstream of Guadalupe River	3/8/2004	10:45	37.26521667	-121.8781167	Water
E3-1b	Ross Creek upstream of River (below Cherry Ave.)	4/23/2004	11:30	37.2636	-121.8854833	Water
E3-1	Ross Creek upstream of Guadalupe River (replicate)	2/27/2004	14:00	37.2655	-121.8786	Water
E3-2a	Canoas Creek at Lean Avenue	2/27/2004	14:45	37.23506667	-121.81665	Water
E3-2b	Canoas Creek @ Lean Ave	4/20/2004	11:40	37.23513333	-121.81705	Water
E3-3	Canoas Creek at Dow Drive	2/27/2004	13:00	37.28026667	-121.8684833	Water
E3-4a	Cannoas Creek upstream of Guadalupe River	2/27/2004	12:05	37.2869	-121.87575	Water
E3-4b	Canoas Creek upstream of Guadalupe River	3/8/2004	9:19	37.28685	-121.8758167	Water
E3-4c	Canoas Creek upstream of Guadalupe River	4/20/2004	9:25	37.28681667	-121.8757	Water
E3-5a	Los Gatos Creek below Vasona Reservoir Outlet	2/27/2004	8:35	37.2473	-121.96515	Water
E3-5b	Los Gatos Creek below Vasona Reservoir Outlet	4/20/2004	8:10	37.24741667	-121.9652833	Water
E3-6	Los Gatos Creek at Camden Avenue	2/27/2004	9:30	37.27433333	-121.9477	Water
E3-7a	Los Gatos Creek above Guadalupe River	2/27/2004	10:20	37.33363333	-121.8991667	Water
E3-7b	Los Gatos Creek above Guadalupe River	3/8/2004	8:45	37.3338	-121.8990333	Water
E3-7c	Los Gatos Creek upstream of	4/20/2004	8:50	37.33355	-121.8985667	Water

Station ID	Station Name	Date	Time	Latitude	Longitude	Media Type
	Guadalupe River					
E4-1a	Guadalupe River above Almaden Drop Structure	2/26/2004	8:50	37.24655	-121.8709167	Water
E4-1b	Guadalupe River above Alamitos Drop Structure	4/20/2004	8:40	37.24663333	-121.8708167	Water
E4-2a	Guadalupe River below Almaden Drop Structure	2/26/2004	9:25	37.24731667	-121.8698167	Water
E4-2b	Guadalupe River below Almaden Drop Structure	3/8/2004	11:30	37.2473	-121.8698667	Water
E4-2c	Guadalupe River below Alamitos Drop Structure	4/20/2004	9:08	37.24726667	-121.8698833	Water
E4-3a	Guadalupe River at Blossom Hill Rd.	2/27/2004	9:15	37.2502	-121.87	Water
E4-3b	Guadalupe River at Blossom Hill Road	4/20/2014	8:20	37.24925	-121.8703667	Water
E4-4a	Guadalupe River upstream of Ross Creek Inflow	2/27/2004	10:10	37.2632	-121.875	Water
E4-4b	Guadalupe River upstream of Ross Creek	3/8/2004	11:10	37.26321667	-121.8751833	Water
E4-4c	Guadalupe River upstream of Ross Creek Inflow	4/20/2004	10:40	37.2631	-121.8753167	Water
E4-5a	Guadalupe River upstream of Canoas Creek Inflow	2/27/2004	10:30	37.281	-121.88	Water
E4-5b	Guadalupe River upstream of Canoas Creek Inflow	3/8/2004	9:42	37.28088333	-121.88005	Water
E4-5c	Guadalupe River upstream of Canoas Creek Inflow	4/20/2004	9:55	37.28511667	-121.88265	Water
E4-6a	Guadalupe River at San Carlos St.	2/27/2004	11:10	37.3277	-121.891	Water
E4-6b	Guadalupe River at San Carlos Street	4/20/2004	11:55	37.3277	-121.8911167	Water
E4-7a	Guadalupe River at Highway 101	2/26/2004	10:25	37.37328333	-121.9326167	Water
E4-7b	Guadalupe River at Hwy 101	4/20/2004	12:25	37.37351667	-121.9320333	Water
E4-7	Guadalupe River at Highway 101	3/8/2004	15:10	37.37335	-121.9322333	Water
E4-8a	Guadalupe River at HWY 237	2/27/2004	12:00	37.3277	-121.968	Water
E4-8b	Guadalupe River at Hwy 237	4/20/2004	13:00	37.40973333	-121.9607167	Water

APPENDIX B QA/QC SUMMARY

A QA/QC Plan (QAPP) (Tetra Tech, 2003e) was prepared to guide the field programs and laboratory analyses. The results of the laboratory QA/QC program are summarized here for the water and sediment analyses.

Aqueous Samples

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004a and 2003e) for collecting and analyzing water samples were followed. The QA/QC results for the mercury analyses showed that the desired detection limits were achieved and verified with method blank analyses. The resulting method detection limits (MDL)s were 0.2 ng/L for total mercury and 0.018 ng/L for methylmercury for one data set (February and March samples) and 0.13 ng/L and 0.019 ng/L for the second data set (April samples). Ten filter blanks were run; one had high concentrations in the filtrate, indicating possible contamination. The total mercury in the blank was less than the filtrate, so it was considered an outlier. The measured total mercury samples had higher mercury than this blank sample. The actual filtered mercury concentrations were much less than in the blank, indicating that this filter blank was not representative. Two laboratory duplicates of five samples were analyzed to check precision of the water analyses for all the mercury species. The relative percent difference (RPD) for total mercury in these duplicates ranged from 2.6 to 22.9 percent, which is within the acceptable range of plus or minus 25 percent. The RPDs for methylmercury ranged from 6.1 to 22.9 percent, which is within the desired limits of 30 percent for methylmercury. Six matrix spike samples were analyzed for all the mercury species; percent recoveries for total mercury ranged from 89.4 to 111.5 percent, while the RPDs were from 0.0 to 5.3 percent, both within acceptable limits. Six analyses of certified reference materials were also performed: the materials used were NIST-1641 for total mercury and DORM-2 for methylmercury. The percent recoveries for total mercury varied from 90.1 to 95.4 percent and 84.5 to 126 percent for methylmercury, which are within the desired limits of 25 percent for total mercury and 30 percent for methylmercury.

In addition to the above laboratory analyses, seven field replicates were collected and analyzed to provide information on the variability contributed by differing field conditions. One replicate sample was considered an outlier by the laboratory, sample E2-2B from Cherry Springs Creek, which had much higher total mercury than the replicate, even though both samples had low suspended solids (1.1 and 1.2 mg/L). The dissolved mercury and methylmercury were similar. Only one bottle was collected in the field; this sample is then split into two bottles so that one part can be filtered in the laboratory. Because the other mercury species were similar, the possible contamination is considered to be from the laboratory, rather than the field. The results for this sample and the calculated particulate fraction was not used for data analysis. All other mercury data were considered usable.

Sulfate and sulfide were analyzed in three water samples; one was a replicate. The MDL for sulfate was 1 mg/L, which was much less than the actual samples (34 to 87 mg/L). The replicate samples were within 1.2 percent. No sulfide was detected in any of the three water samples. The MDL for sulfide was 0.01 mg/L. Both of these analyses met the respective QA/QC criteria.

Sediment

The QA/QC analyses for mercury species in sediment were discussed in Section 6, since all the sediment results were included in the same section. The coarse samples with a significant sand and gravel fraction are quite heterogeneous due to grain size. With such samples, a further complication is that the mineral components are larger, and thus less susceptible to reaction by the digestion agents. One method sometimes used is to grind the samples first to obtain a more uniform grain size distribution of smaller particles. However, there is a potential of loss of mercury by retention on surfaces and loss of any elemental mercury. An alternative digestion method with HF and HCl was tested instead of aqua regia on some of the coarse samples, but the test was not conclusive since neither method extracted higher mercury in all the samples. The variability of results on these samples is partly a function of their differing sources, cinnabar from mine wastes and weathered more soluble compounds from non-mercury enriched soils and other sources in urban runoff.

Sulfate and sulfide were analyzed in four sediment samples; one was a replicate. The MDL for sulfate was 10 mg/kg, which was much less than the actual samples (100 to 450 mg/kg). The RPD for one laboratory duplicate was 8.2 percent, and the matrix spike recoveries ranged from 96.9 to 100.9 percent with a RPD of 2.66 percent. Both of these analyses met the respective QA/QC criteria. The replicate samples were quite different (100 and 450 mg/kg), thought to be due to sample heterogeneity, since the lab variability is low. As explained in Section 6, variations in grain size can be one cause of sample heterogeneity.

APPENDIX C 2004 MERCURY DATA

C.1 AQUEOUS MERCURY SPECIATION IN GUADALUPE RIVER SYSTEM, WINTER 2004

C.2 AQUEOUS MERCURY SPECIATION IN GUADALUPE RIVER SYSTEM, SPRING 2004

C.3 MERCURY SPECIATION IN GUADALUPE RIVER SEDIMENTS

C.4 SEQUENTIAL SELECTIVE EXTRACTIONS OF MERCURY IN GUADALUPE RIVER SEDIMENTS

C.5 BIOAVAILABLE HG OF COARSE INHOMOGENEOUS MATERIAL

C.6 TOTAL HG IN GROUND AND SIZE FRACTIONED SEDIMENTS

C.7 TOTAL HG IN GUADALUPE RIVER SEDIMENTS DIGESTION COMPARISON

Aqueous Mercury Speciation in Guadalupe River System, Winter 2004 (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA phone: 206-622-6960

total Hg by BrCl digestion + $SnCl_2$ reduction, dual amalgamation CVAFS; CH_3Hg by HBr/CH_2Cl_2 extraction + aqueous ethylation + GC-CVAFS

				TOTAL MERCURY					METHYL MERCURY					
	Sampling		TSS	Analysis	Unfiltered	0.4 μ filt	Susp Frac		analysis	UF	0.4 μ filt	Susp Frac		
Sample ID	date	time	mg L-1	Date	ng/L	ng/L	ng/g	log Kd	date	ng/L	ng/L	ng/g	log Kd	comments
E1-01	3/2/2004	12:00	11.1	8-Mar-04	36.6	8.25	2,551	5.49	10-Mar-04	0.328	0.149	16.11	5.03	
E1-01	3/8/2004	14:00	8.9	15-Mar-04	37.5	5.56	3,591	5.81	19-Mar-04	0.233	0.156	8.65	4.74	
E1-02	3/2/2004	15:10	3.7	8-Mar-04	3.47	0.98	682	5.84	12-Mar-04	0.051				
E1-03	3/2/2004	15:00	2	8-Mar-04	8.74	1.19	3,775	6.5	16-Mar-04	0.029				
E1-03-A	3/26/2004	9:30	2	29-Mar-04	2.06	0.79	635	5.91	28-Mar-04	0.144				
E1-03-B	3/26/2004	9:30	2	29-Mar-04	2.03	0.59	720	6.09	28-Mar-04	0.03				
E1-04	3/2/2004	15:35	3.3	8-Mar-04	4.68	0.91	1,160	6.11	12-Mar-04	0.042				
E1-05	3/2/2004	13:35	1.4	8-Mar-04	6.17	3.94	1,593	5.61	12-Mar-04	0.061				
E1-06	3/2/2004	14:30	2.4	8-Mar-04	82.2	11.5	29,463	6.41	12-Mar-04	0.189				
E1-07	3/2/2004	15:30	0.4	8-Mar-04	45.6	24.2	61,257	6.4	16-Mar-04	0.086				
E1-07	3/26/2004	10:31	0.4	29-Mar-04	42.2	23.5	46,725	6.3	28-Mar-04	0.055				
E1-08	3/2/2004	13:35	47.5	8-Mar-04	77.4	6.25	1,498	5.38	10-Mar-04	0.319	0.152	3.52	4.36	
E1-08	3/8/2004	14:50	32.3	15-Mar-04	38.4	5.41	1,022	5.28	19-Mar-04	0.287	0.149	4.28	4.46	
E1-09-A	3/3/2004	9:55	18.9	8-Mar-04	35.1	8.3	1,421	5.23	10-Mar-04	0.185				
E1-09-B	3/3/2004	9:55	18.4	8-Mar-04	18.2	6.68	630	4.97	10-Mar-04	0.199				
E1-09	3/26/2004	9:00	3.2	29-Mar-04	13.4	6.57	2,128	5.51	28-Mar-04	0.047				
E1-10	3/2/2004	14:15	1.3	8-Mar-04	3.33	1.31	1,616	6.09	12-Mar-04	0.035				
E1-11	3/2/2004	13:55	3	8-Mar-04	2.52	1.1	473	5.63	12-Mar-04	0.05				
E1-12	3/2/2004	9:55	17.4	8-Mar-04	19.8	5.04	847	5.23	10-Mar-04	0.103	0.085	1.03	4.08	
E1-12	3/8/2004	13:10	11.8	15-Mar-04	12.92	4.48	715	5.2	19-Mar-04	0.136	0.079	4.83	4.79	
E1-13	3/2/2004	9:25	1.5	8-Mar-04	3.96	2.29	1,152	5.7	12-Mar-04	0.034				
E1-14	3/2/2004	10:30	4.8	8-Mar-04	6.98	3.9	648	5.22	12-Mar-04	0.151				
E1-15	3/2/2004	11:30	12.2	8-Mar-04	32.85	8.61	1,995	5.36	10-Mar-04	0.251	0.11	11.6	5.02	
E1-15	3/3/2004	11:03	10	8-Mar-04	28.83	7.71	2,123	5.44	10-Mar-04	0.257	0.125	13.27	5.03	
E1-16	3/2/2004	8:25	7.7	8-Mar-04	24.67	8.16	2,158	5.42	10-Mar-04	0.216	0.153	8.24	4.73	
E1-16	3/3/2004	11:34	17.9	8-Mar-04	90.54	6.49	4,709	5.86	10-Mar-04	0.289	0.096	10.81	5.05	
E1-17	3/2/2004	9:10	97.6	8-Mar-04	16.44	2.23	146	4.82	10-Mar-04	0.072	0.023	0.5	4.34	
E1-17	3/8/2004	9:45	52.8	15-Mar-04	9.26	1.95	139	4.85	19-Mar-04	0.057	0.01	0.89	4.95	
E1-18	3/2/2004	9:45	3.5	8-Mar-04	2.79	1.63	334	5.31	12-Mar-04	0.032				
E1-19	3/2/2004	10:15	1.2	8-Mar-04	1.96	1.27	575	5.66	12-Mar-04	0.017				
E1-20	3/2/2004	12:25	31.8	8-Mar-04	6.98	1.82	162	4.95	12-Mar-04	0.085				
E1-20	3/8/2004	8:30	2.6	15-Mar-04	1.92	1.63	114	4.84	19-Mar-04	0.014				
E1-21	3/2/2004	11:50	15.2	8-Mar-04	4.1	0.95	207	5.34	12-Mar-04	0.027				
E1-22	3/2/2004	11:00	54.1	8-Mar-04	13.54	1.24	227	5.26	12-Mar-04	0.141				
E2-07	3/8/2004	11:50	8.4	15-Mar-04	13.82	4.42	1,119	5.4	19-Mar-04	0.242	0.139	12.26	4.95	
E2-08	3/26/2004	11:00	1.1	29-Mar-04	13.41	5.86	7,190	6.09	27-Mar-04	0.057				
E2-12	3/8/2004	12:25	3.3	15-Mar-04	86.49	12.42	22,445	6.26	16-Mar-04	0.275	0.19	25.76	5.13	
E3-01-A	2/27/2004	14:00	24.5	8-Mar-04	18.47	6.09	505	4.92	9-Mar-04	0.229	0.089	5.71	4.81	
E3-01-B	2/27/2004	14:00	22.9	3-Mar-04	16.24	6.64	419	4.8	9-Mar-04	0.176	0.101	3.28	4.51	

	Sampling		TSS	TOTAL MERCURY					METHYL MERCURY					
Sample ID	date	time	mg L-1	Analysis Date	Unfiltered ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	analysis date	UF ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	comments
E3-01	3/8/2004	10:45	4	15-Mar-04	5.3	1.97	833	5.63	16-Mar-04	0.062	0.016	11.5	5.86	
E3-02	2/27/2004	14:45	45.6	3-Mar-04	25.21	18.99	136	3.86	10-Mar-04	0.31				
E3-03	2/27/2004	13:00	17.7	3-Mar-04	18.08	9.09	508	4.75	16-Mar-04	0.185				
E3-04	2/27/2004	12:05	12	3-Mar-04	12.28	8.12	347	4.63	9-Mar-04	0.184	0.13	4.5	4.54	
E3-04	3/8/2004	9:19	2.7	15-Mar-04	4.14	2.15	751	5.54	16-Mar-04	0.004	-0.009	nc	nc	
E3-05	2/27/2004	8:35	90.4	3-Mar-04	29.83	5.23	272	4.72	9-Mar-04	0.231	0.044	2.07	4.67	
E3-06	2/27/2004	9:30	74.8	3-Mar-04	28	3.97	321	4.91	9-Mar-04	0.176				
E3-07	2/27/2004	10:20	49.3	3-Mar-04	21.81	4.76	346	4.86	9-Mar-04	0.159	0.038	2.45	4.81	
E3-07	3/8/2004	8:45	2.5	15-Mar-04	2.04	0.99	420	5.63	16-Mar-04	0.017	0.003	5.6	6.27	
E4-01	2/26/2004	8:50	96.4	3-Mar-04	394.4	20.05	3,883	5.29	9-Mar-04	0.915				
E4-02	2/26/2004	9:25	96.1	3-Mar-04	464.6	19.26	4,634	5.38	9-Mar-04	0.737				
E4-02	3/8/2004	11:30	5	15-Mar-04	78.6	11.47	13,426	6.07	16-Mar-04	0.309	0.136	34.6	5.41	
E4-03	2/27/2004	9:15	49.2	3-Mar-04	258.4	20.42	4,837	5.37	9-Mar-04	0.563				
E4-04	2/27/2004	10:10	49.6	3-Mar-04	263	22.22	4,854	5.34	9-Mar-04	0.649				
E4-04	3/8/2004	11:10	6.5	15-Mar-04	66	11.93	8,318	5.84	16-Mar-04	0.292	0.154	21.23	5.14	
E4-05	2/27/2004	10:30	46.1	3-Mar-04	242.7	20.19	4,827	5.38	9-Mar-04	0.603				
E4-05	3/8/2004	9:42	7.7	15-Mar-04	71.43	9.17	8,086	5.95	16-Mar-04	0.302	0.149	19.87	5.13	
E4-06	2/27/2004	11:10	47.6	3-Mar-04	226.5	15.88	4,425	5.45	9-Mar-04	0.594				
E4-07	2/26/2004	10:25	118.6	3-Mar-04	363.9	11.67	2,970	5.41	10-Mar-04	0.748	0.101	5.46	4.73	
E4-07-A	3/8/2004	15:10	5.2	15-Mar-04	19.58	3.84	3,027	5.9	19-Mar-04	0.158	0.088	13.46	5.18	
E4-07-B	3/8/2004	15:10	5.3	15-Mar-04	22.09	3.18	3,568	6.05	19-Mar-04	0.164	0.093	13.4	5.16	
E4-08	2/27/2004	12:00	74.4	3-Mar-04	182.5	10.32	2,314	5.35	9-Mar-02	0.506	0.082	5.7	4.84	
blank-01			-0.25	3-Mar-04	-0.06				9-Mar-04	-0.005				
blank-02			0	3-Mar-04	-0.12				9-Mar-04	0.004				
blank-03			-0.4	3-Mar-04	-0.13				9-Mar-04	0.011				
blank-04			-0.05	3-Mar-04	-0.13				10-Mar-04	0.002				
blank-05			0.05	4-Mar-04	-0.04				10-Mar-04	-0.001				
blank-06			-0.05	4-Mar-04	-0.05				10-Mar-04	0.006				
blank-07			-0.05	4-Mar-04	-0.08				12-Mar-04	-0.003				
blank-08			0	4-Mar-04	-0.04				12-Mar-04	-0.003				
blank-09			0	8-Mar-04	0.04				12-Mar-04	0.003				
blank-10			0	8-Mar-04	0.01				19-Mar-04	0				
blank-11			0	8-Mar-04	-0.02				19-Mar-04	0.001				
blank-12			0	8-Mar-04	-0.02				19-Mar-04	0.004				
blank-13			0.1	15-Mar-04	-0.08				16-Mar-04	0.004				
blank-14				15-Mar-04	-0.04				16-Mar-04	0.001				
blank-15				15-Mar-04	-0.08				16-Mar-04	0.007				
blank-16				15-Mar-04	-0.08				28-Mar-04	0.001				
blank-17				29-Mar-04	0.14				28-Mar-04	0.003				
blank-18				29-Mar-04	0.04				28-Mar-04	0.012				
blank-19				29-Mar-04	0.02				28-Mar-04	0.021				
mean			-0.05		-0.04					0.004				
eMDL			0.4		0.2					0.018				

	Sampling		TSS	TOTAL MERCURY					METHYL MERCURY					
Sample ID	date	time	mg L-1	Analysis Date	Unfiltered ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	analysis date	UF ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	comments
filter blank-1				3-Mar-04	nd	1.03			9-Mar-04	nd	-0.005			
filter blank-2				3-Mar-04	nd	0.72			9-Mar-04	nd	-0.001			
filter blank-3				8-Mar-04	nd	0.25			19-Mar-04	-0.005	-0.005			
filter blank-4				8-Mar-04	0.5	0.28			12-Mar-04	0.001	0.02			
filter blank-5				15-Mar-04	0.73	26.6								
filter blank-6				29-Mar-04	0.01	0.09								
dup. sample			E1-12		E3-07 UF	E3-06 UF				E4-02 UF	E1-9A UF			
replicate 1			17.25	3-Mar-04	17.32	27.12			9-Mar-04	0.759	0.215			
replicate 2			17.6	3-Mar-04	21.81	28.88			9-Mar-04	0.714	0.155			
mean			17.43	3-Mar-04	19.57	28			9-Mar-04	0.737	0.185			
RPD (%)			2	3-Mar-04	22.9	6.3			9-Mar-04	6.1	32.4			
dup. sample			E4-7 FD		E4-02 UF	E1-17 UF				E1-10 UF	E4-7 UF			
replicate 1			5.15	4-Mar-04	470.7	16.64			12-Mar-04	0.031	0.163			
replicate 2			5.3	4-Mar-04	458.6	16.24			12-Mar-04	0.039	0.152			
mean			5.23	4-Mar-04	464.7	16.44			12-Mar-04	0.035	0.158			
RPD (%)			2.9	4-Mar-04	2.6	2.4			12-Mar-04	22.9	7			
dup. sample			E2-8		E1-06 UF	E4-02 UF				E4-4 UF				
replicate 1			1.1	8-Mar-04	80.5	76.9			16-Mar-04	0.268	0.043			
replicate 2			1	8-Mar-04	83.9	80.3			16-Mar-04	0.316	0.051			
mean			1.1	8-Mar-04	82.2	78.6			16-Mar-04	0.292	0.047			
RPD (%)			9.5	8-Mar-04	4.1	4.3			16-Mar-04	16.4	17			
spiked sample					E3-07 UF	E3-07 UF				E4-02 UF	E1-16B UF			
spike level				3-Mar-04	206.2	51.55			9-Mar-04	5	1.667			
sample + spike				3-Mar-04	223.7	72.4			9-Mar-04	5.598	1.983			
% recovery				3-Mar-04	99	102.5			9-Mar-04	97.2	101.6			
spl + spike dup				3-Mar-04	216	68.95			9-Mar-04	5.626	1.794			
% recovery				3-Mar-04	95.3	95.8			9-Mar-04	97.8	90.3			
mean				3-Mar-04	219.9	70.68			9-Mar-04	5.612	1.889			
RPD (%)				3-Mar-04	3.5	4.9			9-Mar-04	0.5	10			
spiked sample					E4-02 UF	E1-04 UF				E1-10 UF	E4-7 UF			
spike level				4-Mar-04	1,031	20.62			12-Mar-04	1.667	1.667			
sample + spike				4-Mar-04	1,640	24.58			12-Mar-04	2.074	1.869			
% recovery				4-Mar-04	114	96.5			12-Mar-04	122.3	102.6			
spl + spike dup				4-Mar-04	1,614	26.66			12-Mar-04	2.163	1.793			
% recovery				4-Mar-04	111.5	106.6			12-Mar-04	128.3	98.1			
mean				4-Mar-04	1,627	25.62			12-Mar-04	2.119	1.831			
RPD (%)				4-Mar-04	1.6	8.1			12-Mar-04	4.2	4.2			

	Sampling		TSS	TOTAL MERCURY					METHYL MERCURY					
Sample ID	date	time	mg L-1	Analysis Date	Unfiltered ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	analysis date	UF ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	comments
spiked sample					E1-06 UF	E4-2 UF				E4-5 UF				
spike level				8-Mar-04	206	103			16-Mar-04	1.667				
sample + spike				8-Mar-04	289	191			16-Mar-04	2.056				
% recovery				8-Mar-04	100.3	109.2			16-Mar-04	105.2				
spl + spike dup				8-Mar-04	301	203			16-Mar-04	2.138				
% recovery				8-Mar-04	106.3	120.8			16-Mar-04	110.1				
mean				8-Mar-04	295	197			16-Mar-04	2.097				
RPD (%)				8-Mar-04	4.2	6			16-Mar-04	3.9				
spiked sample					E1-3A filt									
spike level				29-Mar-04	5.05									
sample + spike				29-Mar-04	5.81									
% recovery				29-Mar-04	99.4									
spl+ spike dup				29-Mar-04	5.51									
% recovery				29-Mar-04	93.5									
mean				29-Mar-04	5.66									
RPD (%)				29-Mar-04	5.3									
ref. material					NIST-1641	NIST-1641				DORM-2	DORM-2			
measured				4-Mar-04	7,576	6,830			9-Mar-04	4,524	4,680			
certified				4-Mar-04	8,010	8,010			9-Mar-04	4,470	4,470			
% recovery				4-Mar-04	94.6	85.3			9-Mar-04	101.2	104.7			
ref. material					NIST-1641	NIST-1641				DORM-2	DORM-2			
measured				8-Mar-04	7,218	7,450			12-Mar-04	5,632	4,134			
certified				8-Mar-04	8,010	8,010			12-Mar-04	4,470	4,470			
% recovery				8-Mar-04	90.1	93			12-Mar-04	126	92.5			
ref. material					NIST-1641	NIST-1641				DORM-2	DORM-2			
measured				15-Mar-04	7,427	7,784			19-Mar-04	4,087	3,984			
certified				15-Mar-04	8,010	8,010			19-Mar-04	4,470	4,470			
% recovery				15-Mar-04	92.7	97.2			19-Mar-04	91.4	89.1			
spl. replicated			E1-01		E1-3A filt									
replicate #1			13.7	29-Mar-04	0.78									
replicate #2			6.8	29-Mar-04	0.8									
replicate #3			12.9											
mean			11.1	29-Mar-04	0.79									
RSD (%)			33.8	29-Mar-04	2.5									
spl. replicated			E1-22											
replicate #1			53.1											
replicate #2			53.2											
replicate #3			56.1											

	Sampling		TSS	TOTAL MERCURY					METHYL MERCURY					
Sample ID	date	time	mg L-1	Analysis Date	Unfiltered ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	analysis date	UF ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	comments
mean			54.1											
RSD (%)			3.2											
spl. replicated			E4-08											
replicate #1			74											
replicate #2			73.8											
replicate #3			75.4											
mean			74.4											
RSD (%)			1.2											

Aqueous Mercury Speciation in Guadalupe River System, Spring 2004 (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA phone: 206-622-6960

total Hg by BrCl digestion + $SnCl_2$ reduction, dual amalgamation CVAFS; CH_3Hg by distillation + aqueous ethylation + GC-CVAFS

				TOTAL MERCURY					METHYL MERCURY					
	Sampling		TSS	Analysis	Unfiltered	0.4 μ filt	Susp Frac		analysis	UF	0.4 μ filt	Susp Frac		
Sample ID	Date	Time	mg/L	Date	ng/L	ng/L	ng/g	log Kd	date	ng/L	ng/L	ng/g	log Kd	comments
E1-01	14-Apr-04	10:10	15.9	19-Apr-04	38.79	3.59	2,214	5.79	22-Apr-04	0.29	0.114	11.07	4.99	
E1-08	14-Apr-04	9:18	12.3	19-Apr-04	23.56	4.82	1,524	5.5	22-Apr-04	0.704	0.179	42.68	5.38	
E1-12	14-Apr-04	9:15	6.3	19-Apr-04	7.03	3.35	584	5.24	22-Apr-04	0.163	0.102	9.68	4.98	
E1-17	20-Apr-04	7:30	23	23-Apr-04	5.86	1.45	192	5.12	24-Apr-04	0.063	0.022	1.78	4.91	
E2-01	14-Apr-04	8:59	12.7	19-Apr-04	32.99	4.37	2,254	5.71	22-Apr-04	0.498				
E2-02A	14-Apr-04	8:48	1.1	19-Apr-04	2.45	1.58	829	5.72	22-Apr-04	0.021				
E2-02B	14-Apr-04	8:48	1.2	19-Apr-04	31.91	1.66	26,304	7.2	22-Apr-04	0.031				high total result verified; possible
E2-03	14-Apr-04	8:22	0.9	19-Apr-04	2.01	0.95	1,247	6.12	22-Apr-04	0.058				contamination of bottle
E2-04	14-Apr-04	7:58	1.8	19-Apr-04	2.74	1.42	754	5.73	22-Apr-04	0.032				
E2-05	14-Apr-04	7:37	13.4	19-Apr-04	32.08	6.34	1,921	5.48	22-Apr-04	0.311	0.164	10.97	4.83	
E2-05	20-Apr-04	10:59	5.6	22-Apr-04	28.07	3.11	4,457	6.16	24-Apr-04	0.355	0.218	24.46	5.05	
E2-06	20-Apr-04	7:45	8.6	22-Apr-04	40.3	4.6	4,151	5.96	28-Apr-04	0.568				
E2-06A	19-Apr-04	12:30	5.8	22-Apr-04	14.66	5.02	1,662	5.52	24-Apr-04	0.456				
E2-06B	19-Apr-04	12:30	6.4	22-Apr-04	15.71	4.67	1,725	5.57	24-Apr-04	0.489				
E2-07	19-Apr-04	10:50	2	22-Apr-04	32.75	3.12	14,815	6.68	22-Apr-04	0.409	0.292	58.5	5.3	
E2-07A	20-Apr-04	9:49	2.2	22-Apr-04	16.06	3.23	5,967	6.27	28-Apr-04	0.386	0.205	84.19	5.61	
E2-07B	20-Apr-04	9:49	2.4	23-Apr-04	15.87	3.11	5,317	6.23	24-Apr-04	0.362	0.243	49.58	5.31	
E2-09	20-Apr-04	13:30	9.1	22-Apr-04	139.5	13.76	13,894	6	24-Apr-04	0.51	0.334	19.45	4.77	
E2-10	19-Apr-04	14:29	4	22-Apr-04	97.33	18.67	19,665	6.02	24-Apr-04	0.486				
E2-10	20-Apr-04	12:50	4.6	23-Apr-04	125.2	16.72	23,842	6.15	28-Apr-04	0.553				
E2-11	19-Apr-04	13:15	2.2	22-Apr-04	34.29	11.56	10,332	5.95	24-Apr-04	0.26				
E2-11	20-Apr-04	12:20	2.6	23-Apr-04	40.32	11.27	11,392	6	28-Apr-04	0.288				
E2-12	19-Apr-04	11:50	2.4	22-Apr-04	39.32	10.94	12,077	6.04	24-Apr-04	0.31	0.165	61.7	5.57	
E2-12	20-Apr-04	10:31	2.8	23-Apr-04	39.19	9.1	10,942	6.08	24-Apr-04	0.282	0.147	49.09	5.52	
E2-13	19-Apr-04	11:27	11.2	22-Apr-04	49.54	4.6	4,030	5.94	22-Apr-04	0.28	0.049	20.72	5.63	
E2-13	20-Apr-04	10:09	12.3	23-Apr-04	36.55	4.57	2,611	5.76	24-Apr-04	0.325	0.042	23.1	5.74	
E2-15	19-Apr-04	13:35	1.1	22-Apr-04	7.89	4.92	2,700	5.74	24-Apr-04	0.182				
E2-16	19-Apr-04	14:00	1.1	22-Apr-04	3.64	2.43	1,152	5.68	24-Apr-04	0.119				
E2-17	14-Apr-04	8:20	3.8	19-Apr-04	4.51	1.82	708	5.59	22-Apr-04	0.15				
E2-18	14-Apr-04	7:45	16.9	19-Apr-04	13.46	1.92	683	5.55	22-Apr-04	0.224				
E3-02	20-Apr-04	11:40	3.9	19-Apr-04	27.97	14.14	3,546	5.4	28-Apr-04	0.346				
E3-04	20-Apr-04	9:25	9.4	19-Apr-04	7.01	2.2	512	5.37	24-Apr-04	0.153	0.016	14.59	5.96	
E3-05	20-Apr-04	8:10	22.9	23-Apr-04	5.85	0.98	213	5.34	24-Apr-04	0.07	0.011	2.58	5.37	
E3-07	20-Apr-04	8:50	2.9	19-Apr-04	2.85	0.64	762	6.08	28-Apr-04	0.015	0.004	3.79	5.98	
E4-01	20-Apr-04	8:40	12.2	19-Apr-04	50.9	4.74	3,784	5.9	28-Apr-04	0.464				
E4-02	20-Apr-04	9:08	13.1	19-Apr-04	65.75	4.91	4,644	5.98	29-Apr-04	0.505	0.078	32.6	5.62	
E4-03	20-Apr-04	8:20	12.9	23-Apr-04	352.3	4.57	27,061	6.77	28-Apr-04	0.632				
E4-04	20-Apr-04	10:40	9.3	23-Apr-04	49.62	4.46	4,856	6.04	28-Apr-04	0.539				
E4-05	20-Apr-04	9:55	7.1	23-Apr-04	40.38	4.27	5,122	6.08	28-Apr-04	0.533				

	Sampling		TSS	TOTAL MERCURY					METHYL MERCURY					
Sample ID	Date	Time	mg/L	Analysis Date	Unfiltered ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	analysis date	UF ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	comments
E4-06	20-Apr-04	11:55	7.9	23-Apr-04	40.74	4.63	4,600	6	28-Apr-04	0.595				
E4-07	20-Apr-04	12:25	6.6	19-Apr-04	14.48	1.63	1,962	6.08	24-Apr-04	0.23	0.061	25.8	5.63	
E4-08	20-Apr-04	1:00	17.7	23-Apr-04	32.83	1.93	1,746	5.96	28-Apr-04	0.294	0.072	12.54	5.24	
E3-01	23-Apr-04		1.1	27-Apr-04	5.35	2.83	2,400	5.93	29-Apr-04	0.36	0.248	106.7	5.63	
E2-14	23-Apr-04		2.8	27-Apr-04	37.06	15.26	7,786	5.71	29-Apr-04	0.426				
filter blank	15-Apr-04			19-Apr-04	0.19	0.16			22-Apr-04	-0.007	-0.004			
filter blank	20-Apr-04			22-Apr-04	0.15	0.03			24-Apr-04	-0.006	-0.006			
filter blank	21-Apr-04			23-Apr-04	na	0.33			28-Apr-04	na	-0.01			
filter blank	24-Apr-04			27-Apr-04	0.26	0.11			29-Apr-04	-0.014	-0.012			
blank-01			0	19-Apr-04	0.03				22-Apr-04	0.013				
blank-02			0.2	19-Apr-04	0.57				22-Apr-04	0.001				
blank-03			0.1	19-Apr-04	0.13				22-Apr-04	0.007				
blank-04			-0.1	19-Apr-04	0.08				24-Apr-04	0.014				
blank-05			0	22-Apr-04	-0.01				24-Apr-04	0.008				
blank-06			0	22-Apr-04	0.01				24-Apr-04	0.014				
blank-07				22-Apr-04	0				28-Apr-04	0.025				
blank-08				22-Apr-04	0.01				28-Apr-04	0.007				
blank-09				23-Apr-04	-0.01				28-Apr-04	0.009				
blank-10				23-Apr-04	0				29-Apr-04	0.019				
blank-11				23-Apr-04	0				29-Apr-04	0.014				
blank-12				23-Apr-04	0				29-Apr-04	0.002				
blank-13				27-Apr-04	0.12									
blank-14				27-Apr-04	0.07									
blank-15				27-Apr-04	0.03									
blank-16				27-Apr-04	0.05									
mean			0.03		0.03					0.011				
SD			0.08		0.05					0.007				
estimated MDL			0.21		0.13					0.019				
duplicated sample				19-Apr-04	E2-1 filt	E2-15 filt			22-Apr-04	E1-12 UF	E2-10 UF			
replicate 1				19-Apr-04	4.23	4.82			22-Apr-04	0.169	0.556			
replicate 2				19-Apr-04	4.51	5.02			22-Apr-04	0.156	0.551			
mean				19-Apr-04	4.37	4.92			22-Apr-04	0.163	0.554			
RPD (%)				19-Apr-04	6.4	4.1			22-Apr-04	8	0.9			
spiked sample				19-Apr-04	E2-1 filt	E2-15 filt			22-Apr-04	E2-3 UF	E4-3 UF			
spike level				19-Apr-04	20.2	20.2			22-Apr-04	1.667	1.667			
sample + MS				19-Apr-04	25.14	25.73			22-Apr-04	1.805	2.506			
% recovery				19-Apr-04	102.8	103			22-Apr-04	104.8	112.4			
sample + MSD				19-Apr-04	23.88	26.47			22-Apr-04	1.75	2.302			
% recovery				19-Apr-04	96.6	106.7			22-Apr-04	101.5	100.2			
mean				19-Apr-04	24.51	26.1			22-Apr-04	1.778	2.404			

	Sampling		TSS	TOTAL MERCURY					METHYL MERCURY					
Sample ID	Date	Time	mg/L	Analysis Date	Unfiltered ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	analysis date	UF ng/L	0.4 μ filt ng/L	Susp Frac ng/g	log Kd	comments
RPD (%)				19-Apr-04	5.1	2.8			22-Apr-04	3.1	8.5			
duplicated sample				23-Apr-04	E1-17 UF	E2-10 UF			24-Apr-04	E2-6B UF	E3-2 UF			
replicate 1				23-Apr-04	5.62	132.3			24-Apr-04	0.471	0.487			
replicate 2				23-Apr-04	6.1	118			24-Apr-04	0.507	0.522			
mean				23-Apr-04	5.86	125.2			24-Apr-04	0.489	0.505			
RPD (%)				23-Apr-04	8.2	11.4			24-Apr-04	7.4	6.9			
spiked sample				23-Apr-04	E1-17 UF	E3-5 UF			24-Apr-04	E2-6A UF	Ross filt			
spike level				23-Apr-04	20.2	20.2			24-Apr-04	1.667	1.667			
sample + MS				23-Apr-04	23.92	23.68			24-Apr-04	2.196	2.116			
% recovery				23-Apr-04	89.4	88.3			24-Apr-04	104.4	105.3			
sample + MSD				23-Apr-04	23.92	22.92			24-Apr-04	2.101	2.116			
% recovery				23-Apr-04	89.4	84.5			24-Apr-04	98.7	105.3			
mean				23-Apr-04	23.92	23.3			24-Apr-04	2.149	2.116			
RPD (%)				23-Apr-04	0	3.3			24-Apr-04	4.4	0			
CRM				19-Apr-04	NIST-1641				22-Apr-04	DORM-2	DORM-2			
observed				19-Apr-04	7,470				22-Apr-04	4,228	3,877			
certified				19-Apr-04	8,010				22-Apr-04	4,470	4,471			
% recovery				19-Apr-04	93.3				22-Apr-04	94.6	86.7			
CRM				22-Apr-04	NIST-1641				24-Apr-04	DORM-2				
observed				22-Apr-04	7,645				24-Apr-04	3,778				
certified				22-Apr-04	8,010				24-Apr-04	4,470				
% recovery				22-Apr-04	95.4				24-Apr-04	84.5				
CRM				23-Apr-04	NIST-1641	NIST-1641			28-Apr-04	DORM-2				
observed				23-Apr-04	7,685	6,828			28-Apr-04	4,055				
certified				23-Apr-04	8,010	8,011			28-Apr-04	4,470				
% recovery				23-Apr-04	95.9	85.2			28-Apr-04	90.7				

Mercury Speciation in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Research Group 414 Pontius North Seattle, WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

total Hg by aqua regia digestion + SnCl2 reduction, dual amalgamation CVAFS; CH3Hg by HBr/CH2Cl2 extraction + aqueous ethylation + GC-CVAFS

	dry	mercury concentrations, as measured				[Hg], ng/g dry basis		percent	
sample	fraction	anal. date	[Hg], ng/g	anal. date	[CH3Hg], ng/g	[Hg]	[CH3Hg]	CH3Hg	comments
E1-9SA	0.719	22-Mar-04	848	18-Mar-04	0.040	1,179	0.056	0.0047	
E1-9SB	0.750	22-Mar-04	135	18-Mar-04	0.040	180	0.053	0.0296	
E2-13 SA	0.898	22-Mar-04	14,772	18-Mar-04	0.058	16,450	0.065	0.0004	
E2-13 SG	0.895	22-Mar-04	16,804	18-Mar-04	0.266	18,775	0.297	0.0016	
E5-1	0.667	24-Mar-04	7,551	24-Mar-04	1.596	11,321	2.393	0.0211	QC sample
E5-2 bank A	0.857	22-Mar-04	21,593	18-Mar-04	1.492	25,196	1.741	0.0069	
E5-2 bank B	0.824	22-Mar-04	15,745	18-Mar-04	1.561	19,108	1.894	0.0099	
E5-2 bottom A	0.692	22-Mar-04	27,181	18-Mar-04	1.467	39,279	2.120	0.0054	
E5-2 bottom B	0.683	22-Mar-04	5,921	18-Mar-04	2.209	8,669	3.234	0.0373	
E5-3 bank A	0.899	24-Mar-04	2,843	24-Mar-04	0.436	3,162	0.485	0.0153	
E5-3 bank B	0.841	24-Mar-04	4,688	24-Mar-04	1.331	5,574	1.583	0.0284	
E5-3 bottom A	0.788	24-Mar-04	51.1	24-Mar-04	0.037	64.8	0.047	0.0724	
E5-3 bottom B	0.725	24-Mar-04	88.5	24-Mar-04	0.031	122	0.043	0.0350	
E5-4 Bank A	0.819	22-Mar-04	2,419	18-Mar-04	1.677	2,954	2.048	0.0693	
E5-4 bank B	0.881	22-Mar-04	2,313	18-Mar-04	1.809	2,625	2.053	0.0782	
E5-4 bank C	0.812	22-Mar-04	2,712	18-Mar-04	1.856	3,340	2.286	0.0684	
E5-4 bank D	0.838	22-Mar-04	2,308	18-Mar-04	1.687	2,754	2.013	0.0731	QC sample
E5-4 bottom A	0.722	22-Mar-04	2,025	18-Mar-04	0.329	2,805	0.456	0.0162	
E5-4 bottom B	0.735	22-Mar-04	216	18-Mar-04	0.465	293	0.633	0.2158	
E5-4 bottom C	0.720	22-Mar-04	269	18-Mar-04	1.423	374	1.976	0.5290	
E5-4 bottom D	0.756	22-Mar-04	312	18-Mar-04	0.520	413	0.688	0.1666	
E5-5 bank A	0.571	24-Mar-04	380	24-Mar-04	0.581	665	1.018	0.1531	
E5-5 bank B	0.615	24-Mar-04	363	24-Mar-04	0.536	590	0.872	0.1476	QC sample
E5-5 bottom A	0.673	24-Mar-04	227	24-Mar-04	0.142	337	0.211	0.0626	
E5-5 bottom B	0.643	24-Mar-04	497	24-Mar-04	0.546	772	0.849	0.1099	
E1-7S	0.726	22-Mar-04	4,797	18-Mar-04	0.104	6,607	0.143	0.0022	

Mercury Speciation in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Research Group 414 Pontius North Seattle, WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

total Hg by aqua regia digestion + SnCl2 reduction, dual amalgamation CVAFS; CH3Hg by HBr/CH2Cl2 extraction + aqueous ethylation + GC-CVAFS

		mercury concentrations, as measured				[Hg], ng/g dry basis			
sample	dry fraction	anal. date	[Hg], ng/g	anal. date	[CH3Hg], ng/g	[Hg]	[CH3Hg]	percent CH3Hg	comments
blank-1		22-Mar-04	0.13	24-Mar-04	0.002				
blank-2		22-Mar-04	0.01	24-Mar-04	0.001				
blank-3		22-Mar-04	-0.01	24-Mar-04	0.004				
blank-4		22-Mar-04	0.02	24-Mar-04	0.009				
blank-5		24-Mar-04	0.14	18-Mar-04	0.001				
blank-6		24-Mar-04	0.01	19-Mar-04	0.002				
blank-7		24-Mar-04	-0.03	20-Mar-04	0.004				
blank-8		24-Mar-04	-0.04	21-Mar-04	0.010				
mean			0.03		0.004				
eMDL			0.21		0.011				
duplicated sample			E5-4 bank D		E5-4 bank D				
replicate #1		22-Mar-04	2,132	18-Mar-04	1.518				
replicate #2		22-Mar-04	2,484	18-Mar-04	1.856				
mean			2,308		1.687				
RPD (%)			15.3		20.0				
spiked sample			E5-4 bank D		E5-4 bank D				
matrix spike			4,936		4.895				
sample + matrix spike		22-Mar-04	6,492	18-Mar-04	8.252				
% recovery			84.8		134.1				
matrix spike dup			4,817		4.951				
sample + matrix spike dup		22-Mar-04	6,775	18-Mar-04	7.279				
% recovery			92.7		112.9				
mean			88.7		123.5				
RPD (%)			9.0		17.1				

Mercury Speciation in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Research Group 414 Pontius North Seattle, WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

total Hg by aqua regia digestion + SnCl2 reduction, dual amalgamation CVAFS; CH3Hg by HBr/CH2Cl2 extraction + aqueous ethylation + GC-CVAFS

		mercury concentrations, as measured			[Hg], ng/g dry basis			
sample	dry fraction	anal. date	[Hg], ng/g	anal. date	[CH3Hg], ng/g	[Hg]	[CH3Hg]	percent CH3Hg	comments
duplicated sample			E5-1		E5-1				
replicate #1		24-Mar-04	6,272	24-Mar-04	1.751				
replicate #2		24-Mar-04	8,829	24-Mar-04	1.441				
mean			7,551		1.596				
RPD (%)			33.9		19.4				
spiked sample			E5-1		E5-1				
matrix spike			16,502		4.735				
sample + matrix spike		24-Mar-04	41,068	24-Mar-04	7.690				
% recovery			203.1		128.7				
matrix spike dup			19,175		4.630				
sample + matrix spike dup		24-Mar-04	39,064	24-Mar-04	8.422				
% recovery			164.3		147.4				
mean			183.7		138.1				
RPD (%)			21.1		13.6				
analytical duplicate			E5-5 bank B						
replicate #1		24-Mar-04	363						
replicate #2		24-Mar-04	399						
mean			381						
RPD (%)			9.4						
analytical spike			E5-5 bank B						
matrix spike			1,122						
sample + matrix spike		24-Mar-04	1,536						
% recovery			102.9						
matrix spike dup			1,122						

Mercury Speciation in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Research Group 414 Pontius North Seattle, WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

total Hg by aqua regia digestion + SnCl2 reduction, dual amalgamation CVAFS; CH3Hg by HBr/CH2Cl2 extraction + aqueous ethylation + GC-CVAFS

		mercury concentrations, as measured				[Hg], ng/g dry basis			
sample	dry fraction	anal. date	[Hg], ng/g	anal. date	[CH3Hg], ng/g	[Hg]	[CH3Hg]	percent CH3Hg	comments
sample + matrix spike dup		24-Mar-04	1,600						
% recovery			108.6						
mean			105.8						
RPD (%)			5.4						
reference material			NIST-2709		IAEA-405				
certified value			1,400		5.49				
measured value		22-Mar-04	1,387	24-Mar-04	5.90				
% recovery			99.1		107.5				
measured value		24-Mar-04	1,414	18-Mar-04	5.75				
% recovery			101.0		104.8				
mean			1,401		5.83				
RPD (%)			1.9		2.6				

Sequential Selective Extractions of Mercury in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA

phone: 206-622-6960 fax: 206-62-6870

samples analyzed according to Bloom, Preus and Katon Anal. Chim. Acta. 479 pp 233-248 (2003)

	dry	Mercury Concentrations, ng/g (ppb)						
sample ID	**fraction**	**F1 (DDW)**	**F2 (pH 2)**	**F3 (KOH)**	**F4 (HNO3)**	**F5 (AQR)**	**sum**	**comments**
E1-7S	0.754	8.09	0.78	209	434	12,074	12,725	*QC sample*
dry basis		10.7	1.03	277	575	16,013	16,877	
% in fraction		0.06	0.01	1.64	3.41	94.9	100.0	
E1-9SA	0.775	1.18	-0.04	36.4	38.9	25.7	102.1	
dry basis		1.52	-0.05	46.9	50.2	33.1	131.8	
% in fraction		1.16	-0.04	35.6	38.1	25.2	100.0	
E1-9SB	0.796	1.07	0.16	33.0	47.2	1,055	1,136	
dry basis		1.34	0.20	41.4	59.3	1,325	1,428	
% in fraction		0.09	0.01	2.90	4.16	92.8	100.0	
E5-1	0.704	31.0	0.60	811	213	2,015	3,070	
dry basis		44.0	0.85	1,152	302	2,862	4,361	
% in fraction		1.01	0.02	26.4	6.93	65.6	100.0	
E5-2 bank	0.818	10.7	0.57	1,012	501	4,255	5,779	
dry basis		13.0	0.70	1,237	612	5,202	7,065	
% in fraction		0.18	0.01	17.51	8.67	73.6	100.0	
E5-2 bottom	0.691	11.6	0.60	873	442	20,243	21,571	
dry basis		16.7	0.87	1,264	640	29,295	31,217	
% in fraction		0.05	0.00	4.05	2.05	93.8	100.0	

Sequential Selective Extractions of Mercury in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA

phone: 206-622-6960 fax: 206-62-6870

samples analyzed according to Bloom, Preus and Katon Anal. Chim. Acta. 479 pp 233-248 (2003)

	dry	Mercury Concentrations, ng/g (ppb)						
sample ID	**fraction**	**F1 (DDW)**	**F2 (pH 2)**	**F3 (KOH)**	**F4 (HNO3)**	**F5 (AQR)**	**sum**	**comments**
E5-4 bank A	0.757	4.32	0.43	349	344	898	1,596	
dry basis		5.71	0.57	461	455	1187	2,109	
% in fraction		0.27	0.03	21.9	21.6	56.3	100.0	
E5-4 bank B	0.764	3.99	0.62	336	382	1,584	2,306	*QC sample*
dry basis		5.22	0.81	439	499	2,073	3,018	
% in fraction		0.17	0.03	14.6	16.5	68.7	100.0	
E5-4 bottom A	0.742	1.83	0.08	64.3	35.5	28.7	130	
dry basis		2.47	0.11	86.7	47.9	38.6	176	
% in fraction		1.40	0.06	49.3	27.2	22.0	100.0	
E5-4 bottom B	0.743	1.35	0.10	70.9	45.2	67.9	185	
dry basis		1.82	0.13	95.4	60.9	91.4	250	
% in fraction		0.73	0.05	38.2	24.4	36.6	100.0	
E5-5 bank	0.658	0.99	0.88	98.8	165	2,900	3,165	
dry basis		1.50	1.34	150	250	4,407	4,810	
% in fraction		0.03	0.03	3.12	5.20	91.6	100.0	
E5-5 bottom	0.604	1.07	0.24	85.9	29.8	354	471	
dry basis		1.77	0.40	142	49.4	587	780	
% in fraction		0.23	0.05	18.2	6.33	75.2	100.0	
blank-1		0.02	0.13	1.5	-0.2	-1.3	0.1	

Sequential Selective Extractions of Mercury in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA

phone: 206-622-6960 fax: 206-62-6870

samples analyzed according to Bloom, Preus and Katon Anal. Chim. Acta. 479 pp 233-248 (2003)

sample ID	dry fraction	Mercury Concentrations, ng/g (ppb) F1 (DDW)	F2 (pH 2)	F3 (KOH)	F4 (HNO3)	F5 (AQR)	sum	comments
blank-2		0.00	0.11	1.7	1.4	-1.4	1.8	
blank-3		0.05	0.25	1.8	2.0	-0.6	3.5	
blank-4		0.07	0.18	1.5	0.4	-0.7	1.4	
mean		0.04	0.17	1.6	0.9	-1.0	1.7	
estimated MDL		**0.09**	**0.19**	**0.5**	**3.0**	**1.2**	**4.2**	
matrix replicate		E5-4 bank B	E5-4 bank B	E5-4 bank B	E5-4 bank B	E5-4 bank B	E5-4 bank B	
replicate #1		4.40	0.74	330	359	2,049	2,743	
replicate #2		3.57	0.50	341	404	1,119	1,868	
mean		3.99	0.62	335	382	1,584	2,306	
RPD (%)		20.8	38.7	3.2	11.8	58.7	38.0	
analytical replicate		E1-7S	E1-7S	E1-7S	E1-7S	E5-4 bank A		
replicate #1		8.50	0.78	210	445	904		
replicate #2		7.67	0.65	208	422	893		
mean		8.09	0.72	209	434	898		
RPD (%)		10.3	18.2	0.7	5.3	1.3		
analytical spiked		E1-7S	E1-7S	E1-7S	E1-7S	E5-4 bank A		
spike level		22.9	3.06	611	917	1,995		
E1-75 + AS		31.6	3.83	874	1,318	2,820		
% recovery		102.7	101.8	108.9	96.4	96.3		
E1-75 + ASD		31.3	4.17	870	1,443	2,928		
% recovery		101.2	112.9	108.1	110.1	101.7		
mean		31.5	4.0	872	1,381	2,874		

Sequential Selective Extractions of Mercury in Guadalupe River Sediments (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA

phone: 206-622-6960 fax: 206-62-6870

samples analyzed according to Bloom, Preus and Katon Anal. Chim. Acta. 479 pp 233-248 (2003)

sample ID	dry fraction	Mercury Concentrations, ng/g (ppb) F1 (DDW)	F2 (pH 2)	F3 (KOH)	F4 (HNO3)	F5 (AQR)	sum	comments
RPD (%)		1.1	8.5	0.5	9.1	3.8		
NIST-2710		217	23.3	684	15,443	14,286	30,653	*certified total*
% in fraction		0.71	0.08	2.23	50.38	46.6	100.0	*32,700 +/- 1,600 ng/g*
HgCl2 rep 1		6,819,227	373,195	476,535	242,813	20,550	7,932,320	*expected total*
HgCl2 rep 2		6,072,190	371,661	457,731	235,272	20,243	7,157,097	*8,716,000 +/- 668,000 ng/g*
mean		6,445,709	372,428	467,133	239,043	20,397	7,544,709	
RPD (%)		11.6	0.4	4.0	3.2	1.5	10.3	
% in fraction		85.4	4.94	6.19	3.17	0.27	100.0	
Hgo		36,273	88,657	263,524	7,931,192	13,331	8,332,977	*expected total*
% in fraction		0.44	1.06	3.16	95.2	0.16	100.0	*7,779,000 +/- 644,000 ng/g*
HgS		132.3	515.7	247.6	1,354	868,157	870,407	*expected total*
% in fraction		0.02	0.06	0.03	0.16	99.7	100.0	*943,000 +/- 28,000 ng/g*
date analyzed		25-Mar-04	26-Mar-04	28-Mar-04	28-Mar-04	31-Mar-04		

Bioavailable Hg (F1 + F2 + F3) leached from 10 gram samples of Coarse Inhomogeneous Material		
analyzed by		
Frontier Geosciences Aquatic Research Group 414 Pontius North Seattle, WA 98109 USA		
phone: 206-622-6960 fax: 206-622-6870		
sample ID	[Hg], ng/g	comments
E5-3 bottom	6.74	
E5-5 Bank A	142.3	*sum of F1-F3 = 100.7 ng/g*
E5-4 Bank-B	302.7	*sum of F1-F3 = 340.1 ng/g*
E2-13SA	231.2	
E5-3 Bank A	48.8	
E5-3 Bank A MD	54.7	
Blank-1	0.2	
Blank-2	0.1	
Blank-3	0.6	
mean	0.3	
estimated MDL	0.8	
E5-3 Bank A rep 1	49.5	
E5-3 Bank A rep 2	48.0	
mean	48.8	
RPD (%)	2.9	
analytical spike level	113.1	
E5-3 Bank A + AS	168.1	
% recovery	105.5	
E5-3 Bank A + ASD	164.8	
% recovery	102.6	
mean	166.4	
RPD (%)	2.0	
NIST-1641d	7.36	aquatic reference material (total Hg in river water)
certified value	8.01	
% recovery	91.9	

Total Hg in Ground and Size Fractioned Sediments (Tetra-Tech Guadalupe River)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North, Seattle WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample were digested using cold aqua regia, and analyzed by dual amalgamation CVAFS

sample date	site	size	ground	analysis date	[Hg], ng/g	comments
2-Mar-04	E1-75	> 2 mm	no	7-Apr-04	1,503	*(43 samples)*
2-Mar-04	E1-75	850 mm - 2 mm	no	8-Apr-04	4,539	
3-Mar-04	E1-9-SA	> 2 mm	no	7-Apr-04	149	
3-Mar-04	E1-9-SA	850 mm - 2 mm	no	7-Apr-04	158	
3-Mar-04	E1-9-SB	500 mm - 850 mm	no	8-Apr-04	230	
3-Mar-04	E1-9-SB	850 mm - 2 mm	no	8-Apr-04	138	
8-Mar-04	E2-13-SA	> 2 mm	no	7-Apr-04	541	*value double checked*
8-Mar-04	E2-13-SA	> 2 mm	yes	7-Apr-04	13,815	*value double checked*
8-Mar-04	E2-13-SA	850 mm - 2 mm	no	7-Apr-04	11,286	*value double checked*
8-Mar-04	E2-13-SA	850 mm - 2 mm	yes	7-Apr-04	9,529	*value double checked*
8-Mar-04	E2-13-SA	whole	yes	7-Apr-04	862	*value double checked*
3-Mar-04	E2-13-SG	> 2 mm	no	7-Apr-04	158	
3-Mar-04	E2-13-SG	850 mm - 2 mm	no	8-Apr-04	53,500	
3-Mar-04	E2-13-SG	850 mm - 2 mm	yes	8-Apr-04	44,311	
3-Mar-04	E2-13-SG	> 2 mm	yes	7-Apr-04	6,210	
3-Mar-04	E2-13 SG	whole	yes	15-Apr-04	52,075	
8-Mar-04	E5-1	850 mm - 2 mm	no	15-Apr-04	91,855	*value double checked*
8-Mar-04	E5-1	500 mm - 850 mm	no	9-Apr-04	9,235	
8-Mar-04	E5-2 bank A	250 mm - 500 mm	no	7-Apr-04	7,738	
8-Mar-04	E5-2 bank A	500 mm - 850 mm	no	7-Apr-04	13,112	
8-Mar-04	E5-2 bottom A	500 mm - 850 mm	no	9-Apr-04	7,827	

Total Hg in Ground and Size Fractioned Sediments (Tetra-Tech Guadalupe River)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North, Seattle WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample were digested using cold aqua regia, and analyzed by dual amalgamation CVAFS

sample date	site	size	ground	analysis date	[Hg], ng/g	comments
8-Mar-04	E5-2 bottom A	250 mm - 500 mm	no	8-Apr-04	40,886	
8-Mar-04	E5-3 bank A	> 2 mm	no	7-Apr-04	105	
8-Mar-04	E5-3 bank A	850 mm - 2 mm	no	7-Apr-04	110	
8-Mar-04	E5-3 bank A	whole	yes	7-Apr-04	831	
8-Mar-04	E5-3 bank B	whole	yes	7-Apr-04	1,340	
8-Mar-04	E5-3 bottom A	850 mm - 2 mm	no	15-Apr-04	706	
8-Mar-04	E5-3 bottom A	whole	yes	7-Apr-04	150	
8-Mar-04	E5-3 bottom A	> 2 mm	no	7-Apr-04	42	
8-Mar-04	E5-4 bank A	5 mm - 50 mm	no	9-Apr-04	2,741	
8-Mar-04	E5-4 bank A	50 mm - 100 mm	no	8-Apr-04	2,105	
8-Mar-04	E5-4 bank B	50 mm - 100 mm	no	7-Apr-04	3,693	
8-Mar-04	E5-4 bank B	5 mm - 50 mm	no	7-Apr-04	5,539	*value double checked*
8-Mar-04	E5-4 bottom A	500 mm - 850 mm	no	8-Apr-04	232	
8-Mar-04	E5-4 bottom A	whole	yes	7-Apr-04	263	
8-Mar-04	E5-4 bottom A	500 mm - 850 mm	no	8-Apr-04	215	
8-Mar-04	E5-4 bottom A	850 mm - 2 mm	no	8-Apr-04	810	
8-Mar-04	E5-4 bottom B	500 mm - 850 mm	no	8-Apr-04	245	
8-Mar-04	E5-4 bottom B	850 mm - 2 mm	no	15-Apr-04	291	
8-Mar-04	E5-5 bank A	5 mm - 50 mm	no	9-Apr-04	599	
8-Mar-04	E5-5 bank A	50 mm - 100 mm	no	9-Apr-04	795	
8-Mar-04	E5-5 bottom A	5 mm - 50 mm	no	9-Apr-04	563	

Total Hg in Ground and Size Fractioned Sediments (Tetra-Tech Guadalupe River)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North, Seattle WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample were digested using cold aqua regia, and analyzed by dual amalgamation CVAFS

sample date	site	size	ground	analysis date	[Hg], ng/g	comments
8-Mar-04	E5-5 bottom A	50 mm - 100 mm	no	7-Apr-04	423	
	blank-1			7-Apr-04	-0.1	
	blank-2			7-Apr-04	-0.1	
	blank-3			7-Apr-04	0.0	
	blank-4			7-Apr-04	-0.1	
	mean				-0.1	
	eMDL				0.2	
	certified value				1,400	
	NIST-2709	whole	no	9-Apr-04	1,473	*NIST reference soil*
	% recovery				105.2	
	NIST-2709	whole	no	7-Apr-04	1,338	
	% recovery				95.6	
	mean				1,406	
	RPD (%)				9.6	
3-Mar-04	E2-13-SG rep 1	> 2 mm	yes	7-Apr-04	6,617	*digestion replicates*
3-Mar-04	E2-13-SG rep 2	> 2 mm	yes	7-Apr-04	5,802	*digestion replicates*
	mean				6,210	
	RPD (%)				13.1	

Total Hg in Ground and Size Fractioned Sediments (Tetra-Tech Guadalupe River)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North, Seattle WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample were digested using cold aqua regia, and analyzed by dual amalgamation CVAFS

sample date	site	size	ground	analysis date	[Hg], ng/g	comments
	matrix spike level				18,416	
3-Mar-04	E2-13-SG + MS	> 2 mm	yes	7-Apr-04	27,842	*digestion spikes*
	% recovery				117.5	
	matrix spike dup level				19,802	
3-Mar-04	E2-13-SG MSD	> 2 mm	yes	7-Apr-04	28,889	*digestion spikes*
	% recovery				114.5	
	mean				116.0	
	RPD (%)				2.5	
8-Mar-04	E5-2 bottom A rep 1	250 mm - 500 mm	no	8-Apr-04	70,393	*digestion replicates*
8-Mar-04	E5-2 bottom A rep 2	250 mm - 500 mm	no	8-Apr-04	11,378	*(coarse, inhomogeneous sample)*
	mean				40,886	
	RPD (%)				144.3	
	matrix spike level				194,175	
8-Mar-04	E5-2 bottom A MS	250 mm - 500 mm	no	8-Apr-04	204,185	*digestion spikes*
	% recovery				84.1	
	matrix spike dup level				187,970	
8-Mar-04	E5-2 bottom A MSD	250 mm - 500 mm	no	8-Apr-04	190,995	*digestion spikes*
	% recovery				79.9	

Total Hg in Ground and Size Fractioned Sediments (Tetra-Tech Guadalupe River)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North, Seattle WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample were digested using cold aqua regia, and analyzed by dual amalgamation CVAFS

sample date	site	size	ground	analysis date	[Hg], ng/g	comments
	mean				82.0	
	RPD (%)				5.2	
8-Mar-04	E2-13-SA rep 1	> 2 mm	no	7-Apr-04	451	*analytical replicates*
8-Mar-04	E2-13-SA rep 2	> 2 mm	no	15-Apr-04	631	*analytical replicates*
	mean				541	
	RPD (%)				33.3	
8-Mar-04	E2-13-SA rep 1	> 2 mm	yes	7-Apr-04	11,909	*analytical replicates*
8-Mar-04	E2-13-SA rep 2	> 2 mm	yes	15-Apr-04	15,720	*analytical replicates*
	mean				13,815	
	RPD (%)				27.6	
8-Mar-04	E2-13-SA rep 1	850 mm - 2 mm	no	7-Apr-04	11,157	*analytical replicates*
8-Mar-04	E2-13-SA rep 2	850 mm - 2 mm	yes	7-Apr-04	11,415	*analytical replicates*
	mean				11,286	
	RPD (%)				2.3	
8-Mar-04	E2-13-SA rep 1	850 mm - 2 mm	yes	7-Apr-04	8,907	*analytical replicates*
8-Mar-04	E2-13-SA rep 2	850 mm - 2 mm	yes	15-Apr-04	10,151	*analytical replicates*
	mean				9,529	

Total Hg in Ground and Size Fractioned Sediments (Tetra-Tech Guadalupe River)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North, Seattle WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample were digested using cold aqua regia, and analyzed by dual amalgamation CVAFS

sample date	site	size	ground	analysis date	[Hg], ng/g	comments
	RPD (%)				13.1	
8-Mar-04	E2-13-SA rep 1	whole	yes	7-Apr-04	860	*analytical replicates*
8-Mar-04	E2-13-SA rep 2	whole	yes	8-Apr-04	860	*analytical replicates*
8-Mar-04	E2-13-SA rep 3	whole	yes	15-Apr-04	868	
	mean				862	
	RSD (%)				0.5	
8-Mar-04	E5-1 rep 1	850 mm - 2 mm	no	15-Apr-04	94,577	*analytical replicates*
8-Mar-04	E5-1 rep 2	850 mm - 2 mm	no	9-Apr-04	89,132	*analytical replicates*
	mean				91,855	
	RPD (%)				5.9	
8-Mar-04	E5-4 bank B rep 1	5 mm - 50 mm	no	7-Apr-04	5,503	*analytical replicates*
8-Mar-04	E5-4 bank B rep 2	5 mm - 50 mm	no	15-Apr-04	5,574	*analytical replicates*
	mean				5,539	
	RPD (%)				1.3	

Total Hg in Guadalupe River Sediments Digestion Comparison (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample ID	prep'n	dry fraction	[Hg], ng/g dry basis AQR	HF	comments
E2-13-SA rep 1	ground	1.000	833	1,060	*note: values in red were from*
E2-13-SA rep 2	ground	1.000	862	1,028	*previous data sets*
mean			**847**	**1044**	
RPD (%)			**3.5**	**3.1**	*"AQR" was digested over night*
AQR/HF			**0.81**		*at room temperature in a mixture of 7:3 HCl + HNO_3 (aqua regia)*
E2-13-SA rep 1	whole	0.898	522	2,195	
E2-13-SA rep 2	whole	0.898	16,450	32,327	*"HF" was digested over night at*
mean			**8,486**	**17,261**	*125° C in a mixture of 6:3:1 HNO_3 +*
RPD (%)			**187.7**	**174.6**	*HF + HCl*
AQR/HF			**0.49**		
E2-13-SG rep 1	ground	1.000	55,264	59,618	
E2-13-SG rep 2	ground	1.000	52,075	57,460	
mean			**53,670**	**58,539**	
RPD (%)			**5.9**	**3.7**	
AQR/HF			**0.92**		
E2-13-SG rep 1	whole	0.895	1,214	5,799	
E2-13-SG rep 2	whole	0.895	18,755	7,366	
mean			**9,985**	**6,583**	
RPD (%)			**175.7**	**23.8**	
AQR/HF			**1.52**		
E5-5 bottom A rep 1	whole	0.604	1,001	504	
E5-5 bottom A rep 2	whole	0.604	780	513	
mean			**891**	**509**	
RPD (%)			**24.8**	**1.8**	
AQR/HF			**1.75**		
McAbee Creek channel rep 1	whole	0.532	9,398	6,855	McAbee Creek is Sample E2-19S bottom.
McAbee Creek channel rep 2	whole	0.532	4,821	27,180	
mean			**7,110**	**17,018**	
RPD (%)			**64.4**	**119.4**	
AQR/HF			**0.42**		
McAbee Creek bank	whole	0.834	18,655	8,258	McAbee Creek is Sample E2-19S bank.
AQR/HF			**2.26**		
NIST-2709 rep 1	ground	1.000	1,396	1,347	
NIST-2709 rep 2	ground	1.000	1,387		
NIST-2709 rep 3	ground	1.000	1,414		
NIST-2709 rep 4	ground	1.000	1,473		

Total Hg in Guadalupe River Sediments Digestion Comparison (Tetra-Tech)

analyzed by

Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA
phone: 206-622-6960 fax: 206-622-6870

sample ID	prep'n	dry fraction	[Hg], ng/g dry basis AQR	HF	comments
NIST-2709 rep 5	ground	1.000	1,338		
mean			1,402	1,347	
SD			49		
RSD (%)			3.5		
certified value			1,400	1,400	
% recovery			100.1	96.2	
AQR/HF				**1.04**	
mean AQR/HF (all)				**1.15**	
SD				**0.64**	
mean AQR/HF (ground)				**0.91**	
SD				**0.11**	
mean AQR/HF (whole)				**1.29**	
SD				**0.81**	
MS level			18,557	35,872	
McAbee Creek channel + MS	whole	0.532	21,857	42,573	
% recovery			79.5	71.2	
MSD level			18,556	35,701	
McAbee Creek channel + MSD	whole	0.532	36,120	48,563	
% recovery			156.3	88.4	
mean recovery			117.9	79.8	
RPD (%)			65.2	21.5	
AS level			1,680		
E2-13-SG + AS	whole	0.895	3,148		
% recovery			115.1		
ASD level			1,680		
E2-13-SG + ASD	whole	0.895	2,886		
% recovery			99.5		
mean recovery			107.3		
RPD (%)			14.5		
blank-1			-0.06	-0.06	
blank-2			0.08	0.40	
blank-3			-0.01	-0.16	
mean			0.00	0.06	
eMDL			0.21	0.90	
date analyzed			7-May-04	7-May-04	

GUADALUPE RIVER WATERSHED MERCURY TMDL PROJECT

AGREEMENT NO. A2643G

TECHNICAL MEMORANDUM 5.3.1

DRAFT DATA COLLECTION REPORT
PART 2: DRY SEASON SAMPLING

Prepared for

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118-3614

Prepared by



TETRA TECH, INC.

3746 Mt. Diablo Blvd., Suite 300
Lafayette, CA 94549-3681

November 15, 2004

TABLE OF CONTENTS

Executive Summary ..... **viii**

1.0 Introduction **1-1**
1.1 Sampling Elements 1-2
1.2 Guide to the Data Collection Report Part 2 Organization 1-3

2.0 Sampling and Laboratory Analysis Methods **2-1**
2.1 Water Column Samples 2-1
2.2 Parameters and Laboratory Analysis Methods for Water 2-3
2.3 Fish Sampling and Analysis Procedures 2-3

3.0 Element 7 Methylmercury Production in Reservoirs **3-1**
3.1 Purpose and Design of Sampling Element 7 3-1
3.2 Sample Results: Reservoirs 3-4
3.3 Comparison of Mercury Results for Reservoirs 3-20
3.4 Assessment of Data Quality and Constraints 3-28
3.5 Comparison with Previous Data 3-29
3.6 Key Findings 3-33

4.0 Estimation of Dry Season Internal Loads and Mercury Exports from Reservoirs **4-1**
4.1 Relating Stage and Reservoir Stored Water Volume 4-2
4.2 Estimating the Depth and Volume of the Hypolimnion 4-2
4.3 Reservoir Outflows 4-6
4.4 Internal loads in reservoirs 4-6
4.5 Exported Loads of Total Mercury and Methylmercury 4-11
4.6 Relating Loads to Previous Calculations 4-12
4.7 Load Estimates and Hypotheses in Conceptual Model 4-14

5.0 Bioaccumulation in Fish **5-1**
5.1 Largemouth Bass Data Set 5-2

5.2 California Roach Data Set 5-9
5.3 Summary and Synthesis of Bioaccumulation Data 5-12

6.0 Recommendations from the Dry Weather Sampling 6-1

7.0 References 7-1

Appendix A Sampling Locations A-1

Appendix B QA/QC Summary B-1

Appendix C Mercury Results in Water and Fish C-1

LIST OF TABLES

Table 2-1. Chemical Parameters and Laboratory Analytical Methods for the Part 2 Season Sampling for the Guadalupe TMDL Project 2-4

Table 2-2. Guadalupe Watershed Largemouth Bass Collection Summary 2-5

Table 3-1. Description of Sampling Stations and Rationale for Element 7: Methylmercury Production in Reservoirs 3-3

Table 3-2. Flows of Reservoir Outlets, Dry Season Sampling 2004 3-5

Table 3-3. Suspended Solids and Mercury Data for Almaden and Guadalupe Reservoirs: Dry Season 2004 3-6

Table 3-4. Water Quality Data for Almaden and Guadalupe Reservoirs: Dry Season 2004 3-11

Table 3-5. Field Parameters for Almaden and Guadalupe Reservoirs: Dry Season 2004 3-13

Table 3-6. Previous Suspended and Mercury Data for Almaden and Guadalupe Reservoirs 3-30

Table 3-7. LAS Data for Almaden Reservoir 2003-2004 3-31

Table 5-1. Summary of Adult Largemouth Bass Mercury Data 5-3

Table 5-2. Summary of Adult Largemouth Bass Data from Surface Water Ambient Monitoring Program 5-7

Table 5-3. Waterbodies Listed By Decreasing Mercury Concentrations (mg/kg wet wt) Standardized For A 40 Cm Largemouth Bass 5-7

Table 5-4. Summary Of Age-1 Largemouth Bass Mercury Data 5-8

Table 5-5. Summary of California Roach Mercury Data 5-12

Table 5-6. Paired Mercury Measurements In Adult Largemouth Bass And Reservoir Water Samples 5-13

Table 5-7. Paired Mercury Measurements In Age-1 Largemouth Bass And Reservoir Water Samples. 5-15
Table 5-8. Trophic Transfer Coefficients, 1-Year Old to Adult Largemouth Bass 5-16
Table 5-9. Summary of Stream Sampling Mercury Data 5-18

LIST OF FIGURES

Figure 3-1. Map showing Sampling Locations at Almaden and Guadalupe Reservoirs. 3-2
Figure 3-2. Temperature and Dissolved Oxygen Profiles for a) Almaden Reservoir and b) Guadalupe Reservoir 3-16
Figure 3-3. Composite Temperature Profiles for Almaden and Guadalupe Reservoirs 3-17
Figure 3-4. Composite Dissolved Oxygen Profiles for Almaden and Guadalupe Reservoirs 3-17
Figure 3-5. Comparison of DOC at different depths in Almaden and Guadalupe Reservoirs 3-18
Figure 3-6. Comparison of Sulfate in Reservoirs 3-19
Figure 3-7. (a) Total mercury, (b) methylmercury, and (c) TSS in Almaden and Guadalupe Reservoir Outlets as measured during the synoptic Survey in 2003 and during the wet and dry season sampling in 2004. 3-21
Figure 3-8. Total and Methylmercury versus Suspended Solids in a) Almaden Reservoir Outlet and b) Guadalupe Reservoir Outlet. 3-22
Figure 3-9. Comparison of Total Mercury in Almaden and Guadalupe Reservoirs 3-22
Figure 3-10. Comparison of Dissolved Mercury in Almaden and Guadalupe Reservoirs 3-23
Figure 3-11. (a) Total (unfiltered) and (b) dissolved (filtered) Methylmercury in Almaden and Guadalupe Reservoirs. 3-24
Figure 3-12. Suspended Solids Concentrations in Almaden and Guadalupe Reservoirs 3-25
Figure 3-13. Change in Mercury Concentrations in Dry Season 3-26
Figure 3-14a. DO and Methylmercury Profiles in Almaden Reservoir 3-27

Figure 3-14b. DO and Methylmercury Profiles in Guadalupe Reservoir. 3-28

Figure 3-15. Total and Methylmercury in Almaden Reservoir Outlet from June 2003 to August 2004 (LAS, 2004) 3-32

Figure 4-1. Volume of water stored as a function of surface elevation for (a) Guadalupe Reservoir, and (b) Almaden Reservoir. 4-3

Figure 4-2. Surface water elevation of (a) Guadalupe Reservoir, and (b) Almaden Reservoir. 4-4

Figure 4-3. The calculated volume of water stored in the hypolimnion and the epilimnion of (a) Guadalupe Reservoir, and (b) Almaden Reservoir. 4-5

Figure 4-4. Average daily outflows from (a) Guadalupe Reservoir, and (b) Almaden Reservoir as reported in SCVWD's online data access system, http://alert.valleywater.org. 4-6

Figure 4-5. (a) Change in volume of the epilimnion and the hypolimnion, (b) the total mercury concentrations, and (c) the water column mass of mercury in the two compartments in Guadalupe Reservoir. 4-8

Figure 4-6. (a) Change in volume of the epilimnion and the hypolimnion, (b) the methylmercury concentrations, and (c) the water column mass of mercury in the two compartments in Guadalupe Reservoir. 4-9

Figure 4-7. (a) Change in volume of the epilimnion and the hypolimnion, (b) the total mercury concentrations, and (c) the water column mass of mercury in the two compartments in Almaden Reservoir. 4-10

Figure 4-8. (a) Change in volume of the epilimnion and the hypolimnion, (b) the methylmercury concentrations, and (c) the water column mass of mercury in the two compartments in Almaden Reservoir. 4-11

Figure 4-9. Daily and cumulative exported loads of (a) total mercury and (b) methylmercury from Guadalupe Reservoir 4-13

Figure 4-10. Daily and cumulative exported loads of (a) total mercury and (b) methylmercury from Almaden Reservoir 4-14

Figure 5-1. Relationship between largemouth bass age and total length (Froese and Pauly, 2004) 5-3

Figure 5-2. Relationship between total length and total mercury concentration in largemouth bass. Hg = -3.954 + 0.171; r^2 = 0.197 5-4

Figure 5-3. Relationship between total length and total mercury concentration in largemouth bass at Guadalupe Reservoir and Lake Alamaden 5-4

Figure 5-4. Mercury concentrations for standardized 40 cm largemouth bass. 5-6

Figure 5-5. Mercury concentrations for standardized 8 cm largemouth bass. 5-10

Figure 5-6. Stream sampling sites in the Guadalupe Watershed (SCVWD, 2004). 5-11

Figure 5-7. Mercury concentration in California roach collected at six locations in the Guadalupe River Watershed. 5-12

Figure 5-8. Relationship between mercury concentrations in adult largemouth bass and methylmercury concentrations in surface (A) and hypolimnetic (B) waters samples. 5-14

Figure 5-9. Relationship between mercury concentrations in age-1 largemouth bass and methylmercury concentrations in surface (A) and hypolimnetic (B) waters samples. 5-16

Figure 5-10. Relationship between mercury concentrations in the tissue of age-1 and adult largemouth bass. 5-17

Figure 5-11. Relationship between mercury concentrations in California Roach and unfiltered total mercury (A) and methylmercury (B) concentrations in water samples. 5-18

Figure 5-12. Relationship between mercury concentrations in California Roach and total mercury (A) and methylmercury (B) concentrations in sediment samples. 5-19

EXECUTIVE SUMMARY

The Data Collection Report Part 2 presents the results of the dry weather phase of the Guadalupe Watershed Total Maximum Daily Load (TMDL) sampling program described in the Data Collection Plan (Technical Memorandum 5.3). A major objective of this effort was to determine the changes in methylmercury concentrations due to stratification of the reservoirs. Total and methylmercury concentrations in both particulate and dissolved phases were measured in the epilimnion and hypolimnion of Almaden and Guadalupe Reservoirs and the outlets on six dates between May 11 and August 31, 2004. This period was dry, with only one small rain event in the upper watershed in May. In addition to the reservoir and outlet sampling, fish samples were collected from the reservoirs, creeks, and main stem Guadalupe River.

Two sampling elements are presented in this document. Element 7 from the Data Collection Plan involved the measurement of mercury during dry weather conditions in two reservoirs. In addition to the samples described in the Data Collection Plan, two sets of multi-depth samples were also collected to better characterize mercury species as a function of depth in the reservoirs.

Sampling Element 6 in the Data Collection Plan describes the measurement of mercury in fish tissue. The sampling effort focused on the development of new information on the concentration of mercury in fish from creeks throughout the watershed, in Guadalupe River, and from the reservoirs. Both data sets are discussed in this report.

Sampling Element 6	**Bioaccumulation in Fish** - Mercury concentrations are quantified in a fish species that represent potential prey items to wildlife and that are consumed by recreational fishermen. The completion of Sampling Element 6 provides the data necessary to establish a linkage between methylmercury concentrations in the water in the creeks and river and fish-tissue concentrations of mercury.

Sampling Element 7 **Methylmercury Production in Reservoirs** - Total and methylmercury and water quality parameters are measured in the upper and lower waters of two reservoirs and the outlets during the development of stratification from spring through summer. The data are used to estimated internal loading and export to creeks.

SAMPLING ELEMENT 7 METHYLMERCURY PRODUCTION IN RESERVOIRS

Total and methylmercury concentrations were measured in the epilimnion and hypolimnion of Almaden and Guadalupe Reservoirs and the outlets. Total mercury concentrations ranged from 3.5 to 39.2 ng/L in the reservoirs and 7.5 to 49.2 ng/L in the outlets. In general, total mercury concentrations were higher in Guadalupe Reservoir than Almaden for the same type of sample. Methylmercury concentrations ranged from 0.2 ng/L to 11.5 ng/L in the reservoirs and 0.85 to 12.8 ng/L in the outlets. Methylmercury concentrations were higher in the hypolimnion and outlet of Guadalupe Reservoir. In both reservoirs, methylmercury concentrations were higher in the hypolimnion (0.41 to 11.5 ng/L) than the epilimnion (0.2 to 0.64 ng/L). The methylmercury concentrations increased over time as the reservoir became more anoxic in the hypolimnion, indicating that internal production is important.

MERCURY LOADS AND EXPORTS IN THE DRY SEASON

Mercury loads produced in two mercury-contaminated reservoirs and exports to downstream creeks were computed during the analysis of dry season data. These loads were compared to wet weather loads reported in Phase I of the data collection.

Both Guadalupe and Almaden Reservoirs were found to be sinks for total mercury on an annual basis. In the wet season (between October 2003 and May 2004), both Guadalupe and Almaden Reservoirs were net sinks of total mercury (Guadalupe load = 241.9 g, export = 149.2 g; Almaden load = 217.8 g, export = 111.8 g). In the dry season, both reservoirs exported total mercury, although there were minimal watershed inflows during this period (Guadalupe export = 37 g, Almaden export = 21 g). Thus, if both wet and dry weather total mercury exports are accounted for, these reservoirs were net sinks over the period of this study.

In contrast to total mercury, both Guadalupe and Almaden Reservoirs were found to be net exporters for methylmercury on an annual basis. In the wet season (between October 2003 and May 2004), the export of methylmercury from the two reservoirs was not very different from the watershed loads, especially for Almaden Reservoir (Guadalupe load = 0.4 g, export = 1.4 g; Almaden load = 0.6 g, export = 0.8 g). In the dry season, when the additional inputs from the watershed were minimal, both reservoirs exported significant quantities of methylmercury (Guadalupe export = 5 g, Almaden export = 7.2 g). The methylmercury was found to be generated in both the hypolimnion and the epilimnion of the reservoirs. On an annual basis, both reservoirs are significant producers and exporters of methylmercury.

SAMPLING ELEMENT 6 FISH SAMPLING

The fish sampling program conducted in 2004 combined several field and laboratory efforts. Different species, size ranges, and locations were sampled. Total mercury concentrations were measured in muscle tissue samples from adult and age-1 largemouth bass (*Micropterus salmoides*) collected at five reservoirs in the Guadalupe Watershed. The large numbers of samples (up to 20) at each reservoir provided an excellent summary of mercury concentrations in this important predatory species. All 89 of the adult largemouth bass samples had edible tissue concentrations of mercury that exceed the State Office of Environmental Health Hazard Assessment (OEHHA) Screening Value (SV) and the U.S. EPA water quality criterion of 0.3 ppm (mg/kg wet wt.). However, both the average and range of mercury concentrations in the adult largemouth bass exhibit large differences between reservoirs. There is an order of magnitude difference in the average total mercury concentrations between Guadalupe Reservoir (6.1 mg/kg wet wt.) and Lexington Reservoirs (0.6 mg/kg wet wt.). The mercury concentrations in the reservoirs in the vicinity of the mining district area of the Guadalupe Watershed were shown to be elevated above the concentrations in other reservoirs in the San Francisco Bay region measured by the Surface Water Ambient Monitoring Program. The concentrations of mercury measured in largemouth bass in Calero and Lexington Reservoirs are more similar to the concentrations measured at other reservoirs in the San Francisco Bay region.

Total mercury concentrations were measured in whole-body samples of age-1 largemouth bass collected at the same five reservoirs in the Guadalupe Watershed. While the variability of the mercury measurements was low within reservoirs, large differences were observed in the fish mercury concentrations between the reservoirs. The total mercury concentrations measured ranged from 0.06 mg/kg wet wt at Lexington Reservoir to 1.5 mg/kg wet wt at Almaden Reservoir. All forty samples from Almaden and Guadalupe Reservoirs had mercury tissue concentrations that exceed the U.S. EPA water quality criterion of 0.3 ppm (mg/kg wet wt.). The age-1 largemouth bass data provide an important baseline on existing methylmercury concentrations in aquatic food webs in the Guadalupe Watershed. These fish will make a good biosentinels to detect changes in response to interventions that reduce methylmercury concentrations in the Watershed's aquatic environment.

Santa Clara Valley Water District biologists collected samples of a small minnow, the California roach (*Lavinia symmetricus*), from six locations in creeks and the Guadalupe River. Whole fish samples, with the gastrointestinal tract removed to prevent contamination with mercury from ingested sediment, were analyzed to quantify the mercury concentrations in fish species that are potential prey items to wildlife species. Statistically significant differences in mercury concentrations were observed between the sampling sites. The measured mercury concentrations ranged from an average value of 0.03 mg/kg wet wt in Los Gatos Creek, which flows from Lexington Reservoir to an average value of 0.39 mg/kg wet wt on Guadalupe Creek, which flows from the Guadalupe Reservoir. At the Guadalupe Creek sampling site,

the mercury concentrations in the tissue of all 20 California roach were greater than the U.S. EPA water quality criterion of 0.3 mg/kg wt wet.

The total mercury concentrations in the three sets of fish samples were compared with unfiltered aqueous methylmercury concentrations measured at the same locations. A strong positive relationship was exhibited between unfiltered methylmercury concentrations in the water column and total mercury in the fish tissue. The values of the Bioaccumulation Factor, the ratio of the tissue concentration to the water column concentration of mercury, were similar among the reservoirs and stream for all three sets of fish samples. The range of BAF values for the age-1 largemouth bass were the lowest: 100,000 – 200,000 . For the California roach the values ranged from 300,000 to 600,000. The highest values were calculated for the adult largemouth bass: 400,000 – 1,000,000.

The results of the fish sampling program provide valuable information to support the use of fish tissue as a numeric target for the TMDL. The relationship between mercury in fish tissue and methylmercury concentrations in the water column indicate the ability to develop an aqueous methylmercury target in addition to a fish-tissue target for this TMDL.

1.0 INTRODUCTION

The objectives of the Data Collection Survey Part 2 were to collect data needed to estimate methylmercury production in reservoirs during the 2004 summer stratification period and to evaluate mercury measurements made in fish tissue sampled from reservoirs and the Guadalupe River and its tributaries. The aqueous mercury results for the reservoirs have been used to estimate the internal loading of mercury to these reservoirs and to refine the previous loading to the Guadalupe Watershed presented in Part 1 of the Data Collection Report (Tetra Tech, 2004a). The fish data have been used to compare mercury concentrations between reservoirs and to evaluate linkage between water column, sediment and fish mercury concentrations. Total and methylmercury concentrations in both the particulate and dissolved phases were measured at multiple depths in Almaden and Guadalupe Reservoirs and in their outlets between May 11 and August 31, 2004. Ancillary water quality and *in-situ* field profile measurements were also made. This report describes the data collection efforts, presents the measured values, and summarizes these new data. These results are intended to complement the wet season sampling, described in Part 1 of the Data Collection Report (Tetra Tech, 2004a) and the previous sampling in the summer of 2003 at 24 locations in the watershed during the dry season (Tetra Tech, 2003a and 2003b). These data have been used to refine the previous mercury loading estimates for the Guadalupe Watershed. The fish mercury data for the reservoirs, creeks, and Guadalupe River are also presented in this report.

The Data Collection Report Part 2: Dry Season Sampling Report is the sixth in a series of products being developed in Phase 1 of the TMDL (Total Maximum Daily Load) for Mercury in the Guadalupe River Watershed. Part 1 of this report presented the results of the wet season sampling of tributaries to the reservoirs and Guadalupe River and the estimated mercury loadings. These Data Collection Reports build on the results of the previous work products that have made important contributions to our understanding of the availability and importance of data for the preparation of the TMDL:

- **Preliminary Problem Statement.** *Technical Memorandum 1.2 Preliminary Problem Statement* (Tetra Tech, 2003c) describes the current understanding of

the processes or factors that are most relevant to controlling mercury in the watershed. The preparation of this report involved the identification, compilation, and evaluation of a wide range of data describing the environmental setting and mercury sources in the watershed.

- **Synoptic Survey.** *Technical Memorandum 2.1.2 Synoptic Survey Plan* (Tetra Tech, 2003a) and *Technical Memorandum 2.2 Synoptic Survey Report* (Tetra Tech, 2003b) describe the preliminary field sampling effort designed to provide an overview of mercury contamination in the upper watershed. The Synoptic Survey was the first sampling program conducted to provide information specifically relevant to the development of the Mercury TMDL. The sampling emphasized the identification and quantification of mercury sources in the watershed and the identification of locations where transformation of solid phase mercury to bioavailable mercury occur.
- **Conceptual Model.** *Technical Memorandum 4.3Draft Final Conceptual Model Report* (Tetra Tech, 2004b) extends the description of our knowledge of existing conditions and describes the biogeochemical processes hypothesized to be controlling mercury transport and fate in the watershed. The mercury conceptual model also provides an up-to-date overview of mercury contamination in the system. Mercury sources, loadings, mercury inventories within the system, and tissue levels within biota are summarized. Water quality, physical data, and significant system characteristics are summarized to describe the variables that affect mercury behavior. The existing data include historical data that have been collected over the past several decades, as well as the results of the Synoptic Survey.
- **Data Collection Plan.** *Technical Memorandum 5.2.3 Data Collection Plan Report* (Tetra Tech, 2004a) describes the data considered essential for development of the TMDL for Mercury in the Guadalupe River Watershed. The sampling plan for the wet season, reservoirs, and fish is included, describing the sampling objectives for the seven major elements, the parameters to be sampled, and the overall sampling approach. The completion of the first five elements of this plan is described in this report.
- **Data Collection Report.** *Technical Memorandum 5.3.1 Data Collection Plan Report Part 1: Wet Season Sampling* (Tetra Tech, 2004b) describes the water quality, sediment, and flow data collected during the wet season of 2004. Mercury concentrations in many of the tributaries to the reservoirs were measured for the first time using the low level methods. The report presents the estimated mercury loads to the San Francisco Bay using the new data along with uncertainty analyses.

1.1 SAMPLING ELEMENTS

The two elements of the dry-weather sampling plan are:

Sampling Element 6	**Bioaccumulation in Fish.** Mercury concentrations are quantified in a fish species that represent potential prey items to wildlife and that are consumed by recreational fishermen. The completion of Sampling Element 6 provides the data necessary to establish a linkage between methylmercury concentrations in the water in the creeks and river and fish-tissue concentrations of mercury.
Sampling Element 7	**Methylmercury Production in Reservoirs.** Total and methylmercury and water quality parameters are measured in the upper and lower waters of two reservoirs and the outlets during the development of stratification from spring through summer. The data are used to estimated internal loading and export to creeks.

The description of the sampling efforts and the results of each of these elements are reported in Section 3 (reservoirs) and in Section 5 (fish).

1.2 GUIDE TO THE DATA COLLECTION REPORT PART 2 ORGANIZATION

The Data Collection Report Part 2 contains seven additional chapters.

2.0 Sampling and Analysis Methods.

Description of parameters measured and the sampling and laboratory analysis methods used for both water and fish.

3.0 Methylmercury Production in Reservoirs.

This section includes a description of Sampling Element 7, the objectives and hypotheses tested, the sampling results, and the use of the data in the TMDL. Data analyses for element 7 in Section 3 include discussion of mercury species, comparisons between mercury and other parameters in the epilimnion and hypolimnion of the reservoirs, and between wet and dry seasons.

4.0 Estimation of Dry Season Internal Loads and Mercury Exports from Reservoirs

The approach to estimating the methylmercury production estimates is described and the major input data used are identified. Internal production in the epilimnion and hypolimnion is estimated and compared. Loads are estimated for total and methylmercury from the reservoirs to Guadalupe and Alamitos Creeks. The dry and wet season loads are compared for each reservoir and the two creeks.

5.0 Bioaccumulation in Fish

This section includes a description of Sampling Element 6, the objectives and hypotheses tested, the sampling results, and use of the data in the TMDL. Data analyses for Element 6 in Section 5 include discussion of mercury concentrations in the adult and juvenile fish samples and comparisons between the locations. Relationships between fish tissue concentrations and water column and sediment mercury are explored.

6.0 Recommendations from the Dry Weather Sampling

Based on the specific findings of the dry weather sampling, the need for additional data collection to provide necessary information for the development of the TMDL for the Guadalupe Watershed is discussed.

7.0 References

The references cited in all chapters are presented in Section 7.

2.0 SAMPLING AND LABORATORY ANALYSIS METHODS

The dry season sampling program included collection and analysis of water column samples from Almaden and Guadalupe Reservoirs and their outlets in the upper Guadalupe watershed. Fish were collected and analyzed for total mercury from four reservoirs, Lake Almaden, and several locations along the Guadalupe River and creeks.

2.1 WATER COLUMN SAMPLES

Measurements of specified water quality parameters (e.g., temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) were made in the field at each sampling site. Water samples were collected from the reservoirs for laboratory analyses of mercury and ancillary parameters. Locations sampled during this phase of the study are identified in Appendix A. The Quality Assurance/Quality Control procedures employed to collect and analyze these data are summarized in Appendix B.

2.1.1 MERCURY WATER SAMPLING

Field personnel followed the "clean hands-dirty hands" procedures of EPA Method 1669 while collecting the water samples for trace-level mercury, as described in the Synoptic Survey Plan (Tetra Tech, 2003a) and in Appendix B.1 to the Data Collection Plan (Tetra Tech, 2004c). The samples for mercury from the reservoir outlet were collected directly into pre-cleaned 500 ml Teflon sample bottles. This sample was collected before the other water quality parameters to avoid disturbance of sediments. All samples were sent to the laboratory via overnight courier service.

Samples were collected from the reservoirs for most dates at two depths: just below the surface at 1 foot and at 50 feet below the surface, which was in the hypolimnion. Additional samples at multiple depths were collected on two dates, July 15 and August 2, 2004, to provide better resolution of mercury concentrations in the

epilimnion and hypolimnion. The reservoir samples from a depth of 1 foot for mercury were collected directly into pre-cleaned 500 ml Teflon sample bottles. The reservoir samples were obtained by pumping from the required depth through specially-cleaned Teflon tubing and a short section of C-flex tubing using a peristaltic pump from the up-wind/up-current side of a non-metallic Zodiac boat. Two volumes of water were pumped and discarded prior to collecting the samples; a low flow rate of about 0.5 per minute was used. The other water quality parameters were collected first to allow more water to pass through the tubing before collecting the mercury sample. The water for the mercury samples was pumped directly into the pre-cleaned Teflon sample bottles to be sent to the analytical laboratory. The Teflon tubing and C-flex tubing were pre-cleaned in a mercury-free environment at the laboratory and double-bagged before being sent to the field for each sampling event. An equipment blank was prepared by pumping mercury-free, distilled water through the tubing and into the Teflon sample bottles. The equipment blanks had total mercury of 0.22 to 0.54 ng/L, and dissolved mercury of <0.15 to 0.25 ng/L. Both unfiltered and filtered methylmercury in the equipment blanks were below detection (0.025 ng/L). The actual water samples had total mercury at close to an order of magnitude higher or greater (2.93 to 49.2 ng/L).

The unfiltered water samples were split into four separate samples for total mercury, unfiltered methylmercury, filtered mercury, and filtered methylmercury analyses in the laboratory. This method makes the species directly comparable, since they come from the same sample bottle. The water sample for filtered mercury and filtered methylmercury was prepared in the laboratory by vacuum filtering through a 0.45 μm disposable nitrocellulose filtration unit, previously found to be non-contaminating for ultra-low level mercury measurements (Bloom, 1994). The filtered sample was poured into a new pre-cleaned sample bottle, and preserved with 0.4 % (v/v) of trace-metals grade HCl acid. The filtered sample was then split into separate samples to be analyzed for filtered mercury and filtered methylmercury.

2.1.2 WATER SAMPLING FOR ANCILLARY WATER QUALITY PARAMETERS

Separate bottles were used to collect water for laboratory analysis of the ancillary parameters. Water samples in the reservoir outlets were collected using two procedures:

Unpreserved samples – Sample bottles that did not contain preservative (e.g., TSS) were rinsed three times with sample water prior to sample collection, and sealed.

Preserved samples – Sample bottles that contained preservative were not rinsed prior to sample collection. Instead, a clean bottle without preservatives was filled, then used to fill the containers with preservatives. The preservatives used in the water samples were: zinc acetate and NaOH for sulfide and sulfuric acid for ammonia and total phosphorus.

All bottles were packed with bubble wrap and placed in an insulated cooler with ice equivalent for shipment to the appropriate laboratory under proper chain of custody.

Reservoir water samples for ancillary parameters were collected using the same method as the mercury samples.

2.1.3 MEASUREMENT OF FIELD PARAMETERS

Handheld instruments were used to measure *in-situ* pH, conductivity, temperature, dissolved oxygen, turbidity, and oxidation-reduction potential in the reservoir outlets where the water samples were collected. Instruments were calibrated before and after field use as described in the QAPP (Tetra Tech, 2003d). In the reservoirs, profiles of *in-situ* pH, temperature, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential were made using a YSI 6820 sonde from the surface to near the bottom of the reservoir at about 5-ft intervals. Water samples were also collected from the reservoirs on August 12,2004 and analyzed in the laboratory by the Winkler method as a QA/QC check. The dissolved oxygen laboratory results were comparable to the field measurements.

2.2 PARAMETERS AND LABORATORY ANALYSIS METHODS FOR WATER

Water samples from two reservoirs were analyzed for total and dissolved mercury, and unfiltered and filtered methylmercury in 57 samples from two to eight depths per sampling date and the reservoir outlets. Suspended solids concentrations were measured in all the reservoir water samples and used to determine the total mercury and methylmercury concentrations in the particulate fraction (i.e., the suspended solids). DOC, nutrients (nitrate, nitrite, ammonia, total phosphorus, total Kjeldahl nitrogen, and chlorophyll-a), sulfate, and sulfide were measured in the outlets and at two depths in the epilimnion and hypolimnion on all the sampling dates in both reservoirs. The laboratory methods for all the parameters in water are shown in Table 2-1.

2.3 FISH SAMPLING AND ANALYSIS PROCEDURES

Two separate sets of fish samples were collected and analyzed for total mercury concentration in the spring and summer of 2004. Personnel from the USEPA Region IX Laboratory and the Santa Clara Valley Water District collected Largemouth bass (*Micropterus salmoides*) samples from five reservoirs in the Guadalupe River Watershed. The Santa Clara Valley Water District (SCVWD) biologists collected samples of the California roach (*Lavina symmetricus*) at six creek and river locations in the watershed.

Table 2-1
Chemical Parameters and Laboratory Analytical Methods for the Part 2 Season Sampling for the Guadalupe TMDL Project

Parameter	EPA Method No.	Units	Reporting Limit
Water			
Total Mercury	1631	ng/L	0.2 ng/L
Dissolved Mercury	1631	ng/L	0.2 ng/L
Methylmercury	1630	ng/L	0.05 ng/L
Filtered Methylmercury	1630	ng/L	0.05 ng/L
Total Suspended Solids	160.2	mg/L	1 mg/L
Sulfate	300 (IC)	mg/L	1mg/L
Sulfide	376.1	mg/L	0.01mg/L
Dissolved Organic Carbon	415.1	mg/L	1 mg/L
Nitrate	300.0	mg/L	0.05 mg/L
Nitrite	300.0	mg/L	0.05 mg/L
Ammonia	350.1	mg/L	0.1 mg/L
Total Phosphorus	365.2	mg/L	0.03 mg/L
Total Kjeldahl Nitrogen	351.3	mg/L	0.5 mg/L
Chlorophyll-a	SM 10200-H	mg/L	0.5 mg/L

Actual reporting limits achieved for mercury were less.

Field Parameters

Specific conductivity, temperature, dissolved oxygen, pH, oxidation-reduction potential, and turbidity were measured in the water samples in the field and as depth profiles in the reservoirs.

2.3.1 LARGEMOUTH BASS SAMPLING

Laregemouth bass samples were collected from five reservoirs in the watershed on August 31, September 1 and September 8, 2004 (Table 2-2). Sampling was accomplished using a Smith-Root boat electroshocker mounted on an 18 foot aluminum boat. Fish were kept alive in a live well on the boat, filled with flowing water from the lake being sampled, until processing was completed.

Two size ranges of fish were targeted for collection at each reservoir: adult fish of legal fishable size > 30.5 cm and small <1 year old fish between 50 – 100 mm fork length. For adult fish, field processing involved measuring the fork length (mm) of each fish, dispatching each with a blow to the head, and wrapping each specimen in a piece of pre-cleaned foil. A unique identifying tag was made for each fish and attached in a plastic bag to the individual specimen. Small fish were measured (fork length in mm), wrapped in individual pre-cleaned foil, and a unique identifying number was written on the outside of each foil. All small specimens were placed in one plastic bag with a tag identifying the reservoir where the collection occurred. The wrapped specimens were placed in a cooler with ice until they could be placed in a freezer at the laboratory each evening. On the last day of sampling, all fish were transported to the USEPA Region 9 Laboratory in coolers with dry ice, and placed in a freezer.

The sampling plan specified the collection of 20 fish from each size class at each reservoir. The target sample numbers were met at Calero Reservoir, Lake Almaden,

and Almaden Reservoir. Due to very low water levels and difficult fishing conditions, 20 small fish and 18 large fish were collected at Guadalupe Reservoir. At Lexington Reservoir, only 11 large fish were collected. The locations, dates, and numbers of fish collected are summarized in Table 2-2.

Table 2-2
Guadalupe Watershed Largemouth Bass Collection Summary

Location	Date	Adult Fish	Small Fish
Calero Reservoir	8/31/2004	20	20
Lake Almaden	8/31/2004	20	20
Almaden Reservoir	9/01/2004	20	20
Guadalupe Reservoir	9/08/2004	18	20
Lexington Reservoir	9/08/2004	11	20

Muscle tissue from the adult fish for mercury analysis was taken from a rectangular cut on the right side of the fish just posterior to the gill and anterior of the dorsal fin above the lateral line. The small fish were analyzed as whole fish samples following the removal of the gastrointestinal tract. The tissue samples were analyzed at the USEPA Region 9 Laboratory using Method 7473/SOP535.

2.3.2 CALIFORNIA ROACH SAMPLING

SCVWD biologists collected California roach samples by backpack electrofisher. Each fish collected for mercury analysis was processed in the following manner:

1) Specimen identification was verified by fin ray counts

2) Measured fork length (mm) on a fix measuring board

3) Weighed (g) using an electronic scale

4) Gastrointestinal tract removed using scissors and a scapula

5) Carcasses were rinsed with deionized water externally and internally

6) Individual samples placed in a sterile container and assigned a specimen number

7) All samples were placed on dry ice for temporary storage in the field then placed into a zero degree freezer at the office until the samples could be transported to the laboratory. Samples were again placed on dry ice for transport to the laboratory for mercury analysis.

Based on the results of the preliminary age analysis sampling and to ensure adequate tissue mass (0.5g or greater) for mercury analysis, only fish measuring 40 to 55 mm were kept and processed.

Nine collection sites were initially selected at the following general locations:

1) Guadalupe River upstream the confluence of Los Gatos Creek

2) Guadalupe River downstream the confluence of Los Gatos Creek

3) Guadalupe Creek upstream Masson Dam

4) Guadalupe Creek downstream Masson Dam

5) Alamitos Creek upstream of Harry Road

6) Alamitos Creek downstream of Harry Road

7) Calero Creek downstream of Harry Road

8) Los Gatos Creek upstream of Vasona Reservoir

9) Los Gatos Creek downstream of Camden Avenue

A total of 114 specimens were collected from six locations of the nine sites selected. In some cases, few or no *L. symmetricus* were present within the planned sampling locations. The sampling design and field sampling results are presented in a SCVWD report (SCVWD, 2004). The fish tissue samples were analyzed at the California Department of Fish and Game Water Pollution Control Laboratory using EPA Method 7473.

3.0 ELEMENT 7 METHYLMERCURY PRODUCTION IN RESERVOIRS

3.1 PURPOSE AND DESIGN OF SAMPLING ELEMENT 7

Methylmercury is the chemical form of mercury most directly linked to uptake by biota and was the focus of Sampling Element 7. An understanding of methylation processes in reservoirs is needed to develop the linkage between water column and fish mercury.

Data collected in Sampling Element 7 was used to address two hypotheses that were proposed in the Conceptual Model:

1. A significant portion of the methylmercury produced in the reservoirs in the warm season is transported downstream to the creeks.
2. Methylation accumulated and/or produced in the epilimnetic zone of the reservoirs during the summer stratification period is significant and makes an important contribution of mercury to the food chain.

Sampling Design: Almaden and Guadalupe Reservoirs were sampled on six dates between May 11 and August 31, 2004. The locations are shown in Figure 3-1. Measurements of total and dissolved mercury and methylmercury in water, and associated parameters (dissolved oxygen, sulfate, sulfide, dissolved organic carbon, and nutrients) were made in Almaden and Guadalupe Reservoir to follow the development of stratification and its effect on net methylmercury production. The mercury samples were collected from the reservoirs from the epilimnion and below the thermocline at mid-depth of the hypolimnion, and at the outlets of the two reservoirs, as listed in Table 3-1. Depth profiles for temperature, specific conductivity, pH, dissolved oxygen, and turbidity were developed using *in situ* measurements.

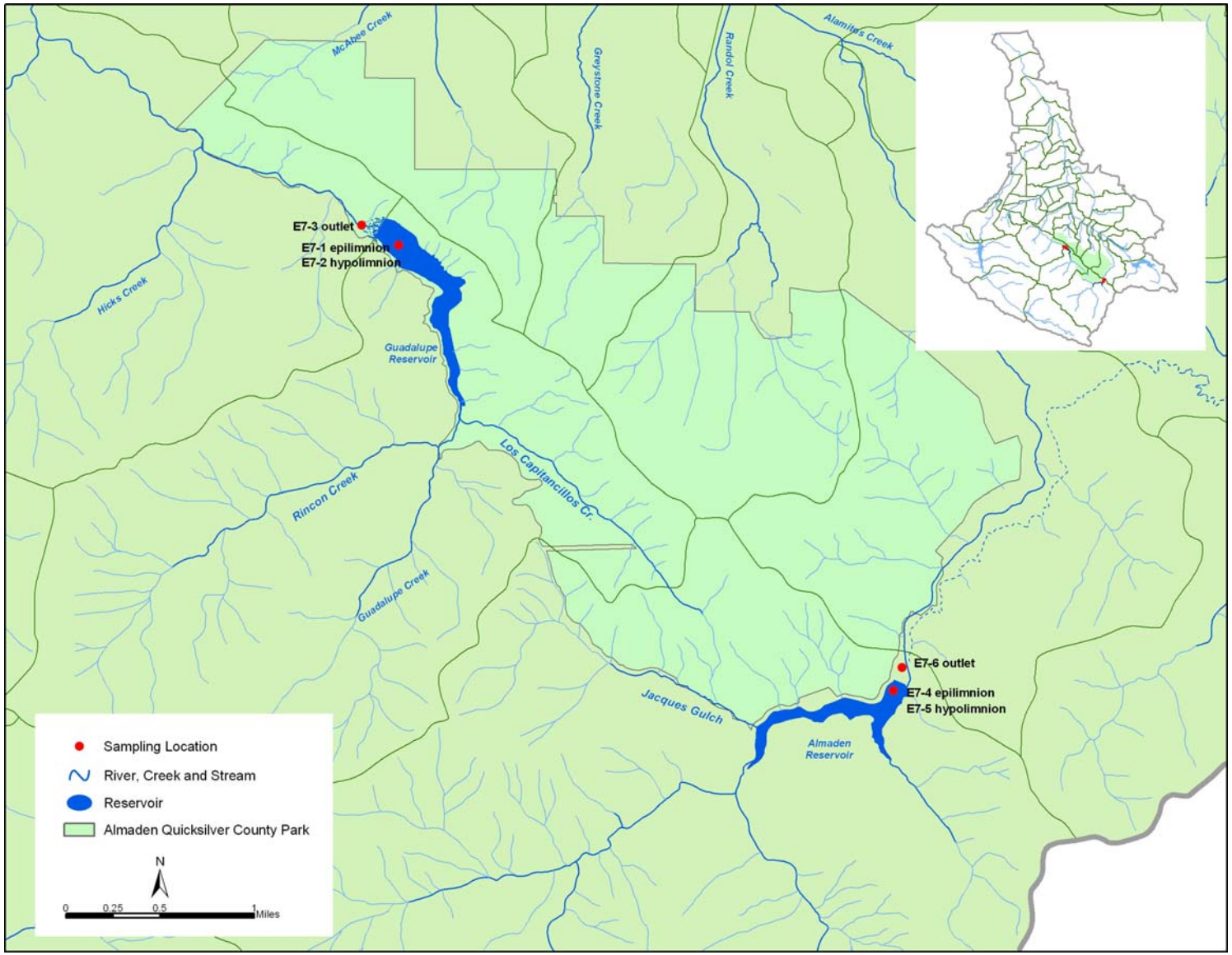


Figure 3-1. Map showing Sampling Locations at Almaden and Guadalupe Reservoirs. The inset shows the entire Guadalupe Watershed.

Table 3-1
Description of Sampling Stations and Rationale for Element 7: Methylmercury Production in Reservoirs

Sampling Site Identifier	Sampling Station Description	Rationale
E7-1	Guadalupe Reservoir above thermocline	Measure total and methylmercury Hg concentrations in epilimnion.
E7-2	Guadalupe Reservoir below thermocline	Measure total and methylmercury Hg concentrations in hypolimnion.
E7-3	Guadalupe Reservoir Outlet	Measure total and methylmercury Hg concentrations, compare to wet weather samples, and use to estimate load to downstream creek.
E7-4	Almaden Reservoir above thermocline	Measure total and methylmercury Hg concentrations in epilimnion.
E7-5	Almaden Reservoir below thermocline	Measure total and methylmercury Hg concentrations in hypolimnion.
E7-6	Almaden Reservoir Outlet	Measure total and methylmercury Hg concentrations, compare to wet weather samples, and use to estimate load to downstream creek.

Additional samples at multiple depths were collected on July 15 and August 2, 2004 in both reservoirs.

Relevance of Data to the Mercury TMDL: The results from this sampling element have been used to provide:

- Key parameters that follow the development of stratification in two reservoirs over time from spring through summer,
- Total mercury and methylmercury in the epilimnion, hypolimnion, and reservoir outlet in two reservoirs to determine how concentrations respond to changes in stratification over time,
- Estimates of mercury loads from two reservoirs to downstream creeks,
- Estimates of internally-generated loads of methylmercury in two reservoirs.

Data gathered through the detailed sampling at the two reservoirs were used to estimate the rate of methylmercury production and transport for each reservoir, and hence the internal methylmercury loading for a reservoir. For the purpose of the TMDL it is important to understand the relative importance of the internal load versus the external load (estimated previously through Wet Weather Sampling Element 1). The sampling results have been used to estimate the internal loads and export to the creeks, as discussed in Section 4.

3.2 SAMPLE RESULTS: RESERVOIRS

Flow data were obtained from the SCVWD online ALERT system. The flows for the reservoir outlets during the six sampling events are presented in Table 3-2. The outflows from both reservoirs were low during the dry season, between 1.7 and 10.3 cfs from Guadalupe Reservoir and between 5.2 and 5.6 cfs from Almaden Reservoir with a few short-duration high flow events (lasting a few hours) of up to 167 cfs. There was only one small rain event in late May during the sampling period with 0.08 inches of rain at the rain gauges within both reservoir watersheds. There were no transfers from Almaden Reservoir to Calero Reservoir during this period with the possible exception of two brief, hour-long events in mid July of 16 and 18 cfs, based on automated gauge readings.

All dry-season data on mercury and related water chemistry in the reservoirs are presented in a series of three tables. Detailed mercury results from the laboratory are also listed in Appendix C. The first of these tables, Table 3-3, presents suspended solids and mercury speciation results of the dry season sampling. Results of the analyses were grouped into the six sampling dates. Data are reported for total suspended solids (TSS), and for unfiltered and filtered total mercury and methylmercury. The mercury content on the suspended particulates was calculated from the total and dissolved mercury concentrations and the suspended solids, as follows:

$$P = (T - D)/SS \times 1000$$

where

P= particulate fraction of mercury in ng/g
T = total mercury in ng/L
D = dissolved mercury in ng/L
SS = suspended solids in mg/L.

The results are expressed on a mass basis, i.e., ng of mercury per gram of suspended matter. The mercury content in the suspended fraction can indicate the mercury concentration of future sediment if it settles at downstream locations. Partition coefficients were also computed for both total and methyl mercury, and are included in Table 3-3. Partition coefficients indicate the tendency of the particulate-associated mercury to be sorbed to particles. The partition coefficients are expressed as log Kd, representing the log of the ratio of mercury in the solid to liquid phases. A higher Kd value indicates that the mercury is more likely to remain in the solid phase, rather than be dissolved into the water column. Conversely, a lower value indicates a decreased capacity for sorption of mercury onto particulates. The coefficients were computed for all the water samples.

Table 3-2.
Flows of Reservoir Outlets, Dry Season Sampling 2004

Station No.	Station Name	Date	Time	Gauged Flow, cfs
E7-6	Almaden Reservoir Outlet	5/112004	10:25	5.39
E7-6	Almaden Reservoir Outlet	6/10/2004	16:45	5.6
E7-6	Almaden Reservoir Outlet	7/15/2004	13:18	13.1
E7-6	Almaden Reservoir Outlet	8/2/2004	9:10	5.39
E7-6	Almaden Reservoir Outlet	8/12/2004	13:13	5.39
E7-6	Almaden Reservoir Outlet	8/31/2004	11:10	5.39
E7-3	Guadalupe Reservoir Outlet	5/112004	14:00	4.5
E7-3	Guadalupe Reservoir Outlet	6/10/2004	13:41	4.5
E7-3	Guadalupe Reservoir Outlet	7/15/2004	9:50	7.8
E7-3	Guadalupe Reservoir Outlet	8/2/2004	10:14	5.2
E7-3	Guadalupe Reservoir Outlet	8/12/2004	9:50	5.2
E7-3	Guadalupe Reservoir Outlet	8/31/2004	11:10	5.7

Data are from the SCVWD online ALERT system.

Table 3-3.
Suspended Solids and Mercury Data for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	TSS mg/L	Total Mercury				Methyl Mercury			
						Unfiltered ng/L	Filtered ng/L	Particulate ng/g	Log Kd Unitless	Unfiltered ng/L	Filtered ng/L	Particulate ng/g	Log Kd Unitless
Guadalupe Reservoir above thermocline	E7-1	5/11/2004	8:30	1	1.9	13.68	2.19	6047.4	6.44	0.566	0.171	207.9	6.08
Guadalupe Reservoir below thermocline	E7-2	5/11/2004	8:30	50	6.1	18.44	5.25	2162.3	5.61	0.463	0.247	35.4	5.16
Guadalupe Reservoir at outlet	E7-3a	5/11/2004	14:00	Outlet	9.4	33.96	4.35	3166.8	5.86	0.853	0.552	32.2	4.77
Guadalupe Reservoir at outlet	E7-3b	5/11/2004	14:00	Outlet	10.7	21.09	4.01	1596.3	5.60	0.972	0.633	31.7	4.70
Almaden Reservoir above thermocline	E7-4	5/11/2004	11:55	1	0.8	3.54	1.86	2100.0	6.05	0.336	0.164	215.0	6.12
Almaden Reservoir below thermocline	E7-5	5/11/2004	12:20	50	1.3	4.10	1.72	1859.4	6.03	0.518	0.298	171.9	5.76
Almaden Reservoir at outlet	E7-6	5/11/2004	10:25	Outlet	1.4	7.69	3.47	2951.0	5.93	2.271	1.219	735.7	5.78
Guadalupe Reservoir above thermocline	E7-1	6/10/2004	12:22	1	4.1	42.80	1.73	10017.1	6.76	0.472	0.157	76.8	5.69
Guadalupe Reservoir below thermocline	E7-2	6/10/2004	12:30	50	2.5	19.70	3.29	6564.0	6.30	0.424	0.226	79.2	5.54
Guadalupe Reservoir at outlet	E7-3	6/10/2004	13:41	Outlet	7.8	33.40	3.36	3851.3	6.06	1.240	0.772	60.0	4.89
Almaden Reservoir above thermocline	E7-4	6/10/2004	14:45	1	1.4	4.09	1.32	1978.6	6.18	0.506	0.333	123.6	5.57
Almaden Reservoir below thermocline	E7-5	6/10/2004	14:45	50	3.4	4.68	2.22	723.5	5.51	1.287	0.817	138.2	5.23
Almaden Reservoir at outlet	E7-6a	6/10/2004	16:45	Outlet	2.4	7.82	2.65	2154.2	5.91	2.771	1.584	494.6	5.49
Almaden Reservoir at outlet	E7-6b	6/10/2004	16:45	Outlet	2.5	7.25	2.29	1984.0	5.94	2.909	1.515	557.6	5.57
Guadalupe Reservoir above thermocline	E7-1a	7/15/2004	7:40	1	4	19.5	2.25	4312.5	6.28	0.299	0.123	44.0	5.6
Guadalupe Reservoir above thermocline	E7-1b	7/15/2004	7:40	1	4	17.6	2.08	3880.0	6.27	0.267	0.117	37.5	5.5
Guadalupe Reservoir about 5' above TMC cusp	E7-7	7/15/2004	8:00	10	4	26.4	2.23	6042.5	6.43	0.338	0.133	51.3	5.6
Guadalupe Reservoir at thermocline cusp	E7-8	7/15/2004	8:10	15	3.5	24.6	2.25	6385.7	6.45	0.572	0.160	117.7	5.9
Guadalupe Reservoir about 5' below TMC cusp	E7-9	7/15/2004	8:20	20	3	14.6	1.84	4253.3	6.36	0.413	0.193	73.3	5.6

Table 3-3.(continued)
Suspended Solids and Mercury Data for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	TSS mg/L	Total Mercury				Methyl Mercury			
						Unfiltered ng/L	Filtered ng/L	Particulate ng/g	Log Kd Unitless	Unfiltered ng/L	Filtered ng/L	Particulate ng/g	Log Kd Unitless
Guadalupe Reservoir below thermocline -35'	E7-10	7/15/2004	8:40	35	2.5	12.4	2.3	4040.0	6.24	0.697	0.488	83.6	5.2
Guadalupe Reservoir below thermocline -50'	E7-2	7/15/2004	8:45	50	1	14.6	3.27	11330.0	6.54	0.965	0.802	163.0	5.3
Guadalupe Reservoir at outlet	E7-3	7/15/2004	9:50	Outlet	4.5	19.1	3.77	3406.7	5.96	1.540	1.010	117.8	5.1
Almaden Reservoir above thermocline	E7-4	7/15/2004	12:00	1	1	4.38	2.16	2220.0	6.01	0.446	0.266	180.0	5.8
Almaden Reservoir about 5' above TMC cusp	E7-11	7/15/2004	12:00	20	1	4.81	1.33	3480.0	6.42	0.513	0.211	302.0	6.2
Almaden Reservoir at thermocline cusp	E7-12	7/15/2004	12:05	25	1	4.08	1.21	2870.0	6.38	0.431	0.226	205.0	6.0
Almaden Reservoir about 5' below TMC cusp	E7-13	7/15/2004	12:10	30	3.5	4.1	1.17	837.1	5.85	0.695	0.190	144.3	5.9
Almaden Reservoir below thermocline -35'	E7-14	7/15/2004	12:17	35	2.5	5.25	1	1700.0	6.23	0.489	0.245	97.6	5.6
Almaden Reservoir below thermocline -50'	E7-5	7/15/2004	12:20	50	3	11.2	2.57	2876.7	6.05	2.300	1.140	386.7	5.5
Almaden Reservoir at outlet	E7-6	7/15/2004	13:18	Outlet	2	15.6	2.33	6635.0	6.45	4.720	1.110	1805.0	6.2
Guadalupe Reservoir above thermocline	E7-1	8/2/2004	11:45	1	3	11	1.5	3166.7	6.3	0.204	0.128	25.3	5.3
Guadalupe Reservoir about 5' above TMC cusp	E7-7	8/2/2004	12:00	10	10	NA	NA	NA	NA	NA	NA	NA	NA
Guadalupe Reservoir at thermocline cusp	E7-8	8/2/2004	12:05	15	3	18.2	2.91	5096.7	6.2	0.360	0.152	69.3	5.7
Guadalupe Reservoir about 5' below TMC cusp	E7-9	8/2/2004	12:15	20	2	31	4.76	13120.0	6.4	0.585	0.145	220.0	6.2
Guadalupe Reservoir below thermocline -35'	E7-10	8/2/2004	12:20	35	8	29.3	7.11	2773.8	5.6	4.990	4.15	105.0	4.4
Guadalupe Reservoir below thermocline	E7-2	8/2/2004	12:25	50	2	6.55	3.6	1475.0	5.6	3.810	3.58	115.0	4.5
Guadalupe Reservoir at outlet	E7-3	8/2/2004	10:14	Outlet	6	14.7	4.4	1716.7	5.6	6.430	3.73	450.0	5.1
Almaden Reservoir above thermocline	E7-4a	8/2/2004	7:30	1	1.7	4.17	1.62	1500.0	6.0	0.582	0.287	173.5	5.8
Almaden Reservoir above thermocline	E7-4b	8/2/2004	7:30	1	2	4.22	1.35	1435.0	6.0	0.511	0.233	139.0	5.8

Table 3-3.(continued)
Suspended Solids and Mercury Data for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	TSS mg/L	Total Mercury				Methyl Mercury			
						Unfiltered ng/L	Filtered ng/L	Particulate ng/g	Log Kd Unitless	Unfiltered ng/L	Filtered ng/L	Particulate ng/g	Log Kd Unitless
Almaden Reservoir about 5' above TMC cusp	E7-11	8/2/2004	7:40	25	2.3	4.92	1.66	1417.4	5.9	0.644	0.272	161.7	5.8
Almaden Reservoir at thermocline cusp	E7-12	8/2/2004	7:50	30	1	15.1	4.22	10880.0	6.4	0.585	0.25	335.0	6.1
Almaden Reservoir about 5' below TMC cusp	E7-13	8/2/2004	8:00	35	<1.0	4.71	2.83	1880.0	5.8	0.526	0.357	169.0	5.7
Almaden Reservoir below thermocline -40	E7-14	8/2/2004	8:20	40	1.5	19.8	1.79	12006.7	6.8	0.985	0.684	200.7	5.5
Almaden Reservoir below thermocline	E7-5	8/2/2004	8:20	50	3.5	4.07	1.33	782.9	5.8	2.070	1.07	285.7	5.4
Almaden Reservoir at outlet	E7-6	8/2/2004	9:10	Outlet	3	20.8	2.33	6156.7	6.4	4.150	2.38	590.0	5.4
Guadalupe Reservoir above thermocline	E7-1	8/12/2004	8:05	1	3.5	13.2	1.44	3360.0	6.4	0.324	0.117	59.1	5.7
Guadalupe Reservoir below thermocline	E7-2a	8/12/2004	8:10	50	7.5	32.3	9.88	2989.3	5.5	11.000	8.27	364.0	4.6
Guadalupe Reservoir below thermocline	E7-2b	8/12/2004	8:16	50	7	26	7.32	2668.6	5.6	5.090	5.47	NA	NA
Guadalupe Reservoir at outlet	E7-3	8/12/2004	9:50	Outlet	4.5	19.8	8.6	2488.9	5.5	8.100	6.08	448.9	4.9
Almaden Reservoir above thermocline	E7-4	8/12/2004	12:21	1	1.3	3.25	1.12	1638.5	6.2	0.466	0.237	176.2	5.9
Almaden Reservoir below thermocline	E7-5	8/12/2004	12:03	50	3	10.5	4.06	2146.7	5.7	1.830	2.81	NA	NA
Almaden Reservoir at outlet	E7-6	8/12/2004	13:13	Outlet	4	12.7	1.85	2712.5	6.2	7.200	4.29	727.5	5.2
Guadalupe Reservoir above thermocline	E7-1	8/31/2004	12:45	1	4.5	11.8	1.00	2400.0	6.4	0.272	0.085	41.6	5.7
Guadalupe Reservoir below thermocline	E7-2	8/31/2004	13:25	50	9	39.4	11.00	3155.6	5.5	11.50	7.20	477.8	4.8
Guadalupe Reservoir at outlet	E7-3	8/31/2004	14:30	Outlet	11.5	49.2	12.20	3217.4	5.4	12.80	7.24	483.5	4.8
Almaden Reservoir above thermocline	E7-4	8/31/2004	8:30	1	4	2.93	1.12	452.5	5.6	0.369	0.277	23.0	4.9
Almaden Reservoir below thermocline	E7-5a	8/31/2004	10:00	50	4	12.3	3.08	2305.0	5.9	5.49	3.09	600.0	5.3
Almaden Reservoir below thermocline	E7-5b	8/31/2004	10:00	50	2	11.0	3.53	3735.0	6.0	5.09	2.68	1205.0	5.7
Almaden Reservoir at outlet	E7-6	8/31/2004	11:10	Outlet	3.5	14.3	3.48	3091.4	5.9	6.47	3.69	794.3	5.3

Key findings from data on mercury speciation presented in Table 3-3 are summarized below. A subsequent section in this chapter evaluates these data graphically.

- **Suspended solids.** The suspended solids concentrations ranged from 0.8 to 4 mg/L in Almaden Reservoir and 1.4 to 3.5 mg/L in the outlet. In Guadalupe Reservoir, the suspended solids concentrations ranged from 1.9 to 10 mg/L and from 4.5 to 11.5 mg/L in the outlet.

- **Total mercury.** Total mercury concentrations were somewhat higher in Guadalupe Reservoir compared to Almaden Reservoir and ranged as follows:

  Almaden Reservoir
  - epilimnion 3.54 to 4.9 ng/L
  - hypolimnion 4.10 to 19.8 ng/L
  - outlet 7.25 to 20.8 ng/L, and

  Guadalupe Reservoir
  - epilimnion 11.0 to 42.8 ng/L
  - hypolimnion 6.5 to 39.4 ng/L
  - outlet 14.7 to 49.2 ng/L.

- **Methylmercury.** Methylmercury concentrations were a significant fraction of the total mercury (sometimes more than 20% of total mercury). Methylmercury concentrations were higher in Guadalupe Reservoir and ranged as follows:

  Almaden Reservoir
  - epilimnion 0.34 to 0.64 ng/L
  - hypolimnion 0.43 to 5.49 ng/L
  - outlet 2.91 to 7.20 ng/L, and

  Guadalupe Reservoir
  - epilimnion 0.20 to 0.57 ng/L
  - hypolimnion 0.41 to 11.5 ng/L
  - outlet 0.85 to 12.8 ng/L.

- **Mercury in Particulate Fraction.** The total mercury in the particulate fraction from the Almaden Reservoir outlet varied from 1,984 ng/g to 6,635 ng/g, compared to 1,596 ng/g to 3,851 ng/g from the Guadalupe Reservoir outlet. Somewhat higher concentrations (higher by a factor of 2) were calculated for samples collected inside the reservoirs. The particulate mercury concentrations were not too different for the two reservoirs studied here, confirming the presence of a similar mercury source.
- **Partition Coefficients.** The log Kd values for total mercury were similar for the two reservoirs, ranging from 5.5 to 6.8 for Almaden Reservoir and from 5.4 to 6.76 for Guadalupe Reservoir. The log Kd values for methylmercury ranged from 5.2 to 6.2 for Almaden Reservoir and from 4.4 to 6.2 for Guadalupe Reservoir. The Guadalupe Reservoir samples with lower partition coefficients were the deeper samples from the hypolimnion and outlet.

Differences in partitioning can result from water quality factors such as pH, DOC, type of organic acids present, and from differences in particle grain size or composition. The reason for the difference in not known, but could be related to the higher DOC in most deep Guadalupe Reservoir samples.

The second major data table in this chapter, Table 3-4, presents the results of water quality parameters that are measured in the laboratory (such as nutrients, sulfate, chlorophyll a, etc.). The next data table, Table 3-5 contains the results of parameters that are measured in the field directly (such, pH, temperature, dissolved oxygen, etc.). For these data, we summarize the key findings and further evaluate the data graphically where appropriate.

- **Temperature and Dissolved Oxygen.** Both reservoirs were stratified with respect to temperature beginning in May, as seen in Figure 3-2a for Almaden Reservoir and 3-2b for Guadalupe Reservoir. Almaden Reservoir had a smaller temperature change over its depth than Guadalupe, and stratified sooner than Guadalupe. The temperature change began at 10 to 30 feet in Almaden Reservoir (Figure 3-3), and the depth of the warmer layer increased gradually over the summer in Almaden Reservoir. Between mid to late August, the temperature difference decreased with depth as the reservoir started to turn over. There was still a gradient with respect to dissolved oxygen at the end of August. The temperature change began at 15 to 20 feet in Guadalupe Reservoir, and it was still stratified at the end of August. The dissolved oxygen profiles differed between the two reservoirs, as seen in Figure 3-4. Almaden Reservoir was anoxic below 60 feet by May 11th, while Guadalupe had dissolved oxygen concentrations above 2 mg/L until after June 10th. Dissolved oxygen in the epilimnion of Almaden varied from 8.2 to 11 mg/L, which was similar to the epilimnion of Guadalupe 7.5 to 11 mg/L. On any given date, the dissolved oxygen in the epilimnion varied over a narrow range in both reservoirs. The dissolved oxygen decreased with depth in the hypolimnion and was less than 1 mg/L at a depth of 25 feet in Guadalupe Reservoir by July and at a depth of less than 35 feet in Almaden Reservoir by June 10th. Due to withdrawals from the reservoirs, the depth had decreased by about 25 feet in both reservoirs by the end of August. An average depth of the thermocline of 25 feet was used for the loading analysis in Chapter 4.

Table 3-4.
Water Quality Data for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	Ammonia Nitrogen mg/L	Nitrate Nitrogen mg/L	Nitrite Nitrogen mg/L	TKN mg/L	Total Phosphorus mg/L	Chlorophyll a mg/L	DOC mg/L	Sulfate mg/L	Total Sulfides mg/L
Guadalupe Reservoir above thermocline	E7-1	5/11/2004	8:30	1	0.56	<0.05	<0.05	<0.5	NA	<10	2.1	13	0.01
Guadalupe Reservoir below thermocline	E7-2	5/11/2004	8:30	50	0.41	0.13	<0.05	<0.5	NA	<10	2.4	12	<0.01
Guadalupe Reservoir at outlet	E7-3a	5/11/2004	14:00	Outlet	0.18	0.19	<0.05	<0.5	NA	<10	2.6	12	<0.01
Guadalupe Reservoir at outlet	E7-3b	5/11/2004	14:00	Outlet	0.74	0.18	<0.05	<0.5	NA	<10	2.5	12	0.04
Almaden Reservoir above thermocline	E7-4	5/11/2004	11:55	1	<0.1	<0.05	<0.05	<0.5	NA	<10	1.4	14	<0.01
Almaden Reservoir below thermocline	E7-5	5/11/2004	12:20	50	<0.1	<0.05	<0.05	<0.5	NA	<10	1.4	13	<0.01
Almaden Reservoir at outlet	E7-6	5/11/2004	10:25	Outlet	0.12	<0.05	<0.05	<0.5	NA	<10	1.5	12	<0.01
Guadalupe Reservoir above thermocline	E7-1	6/10/2004	12:22	1	0.75	<0.05	<0.05	<0.5	0.16	<10	2.7	16	0.021
Guadalupe Reservoir below thermocline	E7-2	6/10/2004	12:30	50	0.53	0.08	<0.05	0.7	0.16	<10	3.0	14	0.011
Guadalupe Reservoir at outlet	E7-3	6/10/2004	13:41	Outlet	0.31	0.16	<0.05	<0.5	0.15	<10	3.2	14	0.022
Almaden Reservoir above thermocline	E7-4	6/10/2004	14:45	1	0.46	<0.05	<0.05	<0.5	0.13	<10	2.2	17	0.015
Almaden Reservoir below thermocline	E7-5	6/10/2004	14:45	50	0.2	<0.05	<0.05	<0.5	0.13	<10	1.8	16	0.018
Almaden Reservoir at outlet	E7-6a	6/10/2004	16:45	Outlet	0.31	<0.05	<0.05	<0.5	0.17	<10	2.0	15	0.032
Almaden Reservoir at outlet	E7-6b	6/10/2004	16:45	Outlet	0.37	<0.05	<0.05	<0.5	0.084	<10	2.1	15	0.033
Guadalupe Reservoir above thermocline	E7-1a	7/15/2004	7:40	1	0.25	<0.05	<0.05	<0.5	<0.03	<10	2.8	17	0.017
Guadalupe Reservoir above thermocline	E7-1b	7/15/2004	7:40	1	<0.1	<0.05	<0.05	<0.5	<0.03	<10	2.5	17	<0.01
Guadalupe Reservoir below thermocline	E7-2	7/15/2004	8:45	50	<0.1	<0.05	<0.05	<0.5	<0.03	<10	2.4	14	0.013
Guadalupe Reservoir at outlet	E7-3	7/15/2004	9:50	Outlet	<0.1	0.07	<0.05	<0.5	0.06	<10	<1	14	0.01
Almaden Reservoir above thermocline	E7-4	7/15/2004	12:00	1	<0.1	<0.05	<0.05	<0.5	0.046	<10	1.6	18	0.011
Almaden Reservoir below thermocline	E7-5	7/15/2004	12:20	50	0.13	<0.05	<0.05	0.56	0.042	<10	1.1	15	0.01
Almaden Reservoir at outlet	E7-6	7/15/2004	13:18	Outlet	<0.1	<0.05	<0.05	0.7	0.15	<10	1.7	14	0.052
Guadalupe Reservoir above thermocline	E7-1	8/2/2004	11:45	1	0.32	<0.05	<0.05	<0.5	<0.03	<0.5	2.7	17	<0.01

Table 3-4.(continued)
Water Quality Data for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	Ammonia Nitrogen mg/L	Nitrate Nitrogen mg/L	Nitrite Nitrogen mg/L	TKN mg/L	Total Phosphorus mg/L	Chlorophyll a mg/L	DOC mg/L	Sulfate mg/L	Total Sulfides mg/L
Guadalupe Reservoir below thermocline	E7-2	8/2/2004	12:25	50	0.27	<0.05	<0.05	<0.5	0.035	<0.5	2.6	13	<0.01
Guadalupe Reservoir at outlet	E7-3	8/2/2004	10:14	Outlet	0.22	<0.05	<0.05	<0.5	0.049*	<0.5	3.5	13	<0.01
Almaden Reservoir above thermocline	E7-4a	8/2/2004	7:30	1	0.11	0.07	<0.05	<0.5	<0.03	<0.5	2.2	16	<0.01
Almaden Reservoir above thermocline	E7-4b	8/2/2004	7:30	1	<0.10	<0.05	<0.05	<0.5	<0.03	<0.5	2.2	16	<0.01
Almaden Reservoir below thermocline	E7-5	8/2/2004	8:20	50	<0.10	<0.05	<0.05	<0.5	0.062*	<0.5	2.1	15	0.028
Almaden Reservoir at outlet	E7-6	8/2/2004	9:10	Outlet	0.22	<0.05	<0.05	<0.5	0.52	<0.5	2.5	13	0.12
Guadalupe Reservoir above thermocline	E7-1	8/12/2004	8:05	1	0.24	<0.05	<0.05	<0.50	0.085	<0.5	3.5	18	<0.01
Guadalupe Reservoir below thermocline	E7-2a	8/12/2004	8:10	50	0.12	<0.05	<0.05	<0.50	0.05	<0.5	2.5	14	<0.01
Guadalupe Reservoir below thermocline	E7-2b	8/12/2004	8:16	50	<0.10	<0.05	<0.05	<0.50	0.59	<0.5	2.4	14	0.07
Guadalupe Reservoir at outlet	E7-3	8/12/2004	9:50	Outlet	<0.10	<0.05	<0.05	0.56	0.035	<0.5	2.6	12	<0.01
Almaden Reservoir above thermocline	E7-4	8/12/2004	12:21	1	<0.10	<0.05	<0.05	<0.50	<0.030	<0.5	2	16	<0.01
Almaden Reservoir below thermocline	E7-5	8/12/2004	12:03	50	0.11	<0.05	<0.05	0.56	0.052	<0.5	1.9	14	0.084
Almaden Reservoir at outlet	E7-6	8/12/2004	13:13	Outlet	0.28	<0.05	<0.05	0.98	0.077	<0.5	2.1	13	0.17
Guadalupe Reservoir above thermocline	E7-1	8/31/2004	12:45	1	0.31	<0.05	<0.05	<0.5	<0.03	<0.5	3	19	<0.01
Guadalupe Reservoir below thermocline	E7-2	8/31/2004	13:25	50	0.26	<0.05	<0.05	<0.5	0.04	<0.5	2.5	14	0.14
Guadalupe Reservoir at outlet	E7-3	8/31/2004	14:30	Outlet	0.27	<0.05	<0.05	<0.5	<0.030	<0.5	2.6	13	0.01
Almaden Reservoir above thermocline	E7-4	8/31/2004	8:30	1	0.16	<0.05	<0.05	<0.5	0.031	<0.5	2.1	15	<0.01
Almaden Reservoir below thermocline	E7-5a	8/31/2004	10:00	50	0.26	<0.05	<0.05	<0.5	0.071	<0.5	2.2	15	0.06
Almaden Reservoir below thermocline	E7-5b	8/31/2004	10:00	50	0.26	<0.05	<0.05	0.98	0.07	<0.5	2.1	15	0.058
Almaden Reservoir at outlet	E7-6	8/31/2004	11:10	Outlet	0.45	<0.05	<0.05	0.84	0.05	<0.5	2.3	14	0.042

NA = not applicable
*Values shown are from retest (past hold). Original values were outliers; 7.8 mg/L for E7-3 and 3.5 mg/L for E7-5.

Table 3-5.
Field Parameters for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	Conductivity uS/cm	D.O. sat.% Saturation	D.O.m g/L	pH S.U.	Temperature °C	Turbidity NTUs	ORP milivolts
Guadalupe Reservoir above thermocline	E7-1	5/11/2004	8:30	1	290	115.40	10.44	8.33	20.01	2.80	NA
Guadalupe Reservoir below thermocline	E7-2	5/11/2004	8:30	50	211	73.00	8.08	7.39	10.76	8.80	NA
Guadalupe Reservoir at outlet	E7-3	5/11/2004	14:00	Outlet	304	79.80	8.84	7.39	10.81	25.40	NA
Almaden Reservoir above thermocline	E7-4	5/11/2004	11:55	1	341	118.30	10.74	8.57	20.10	1.10	NA
Almaden Reservoir below thermocline	E7-5	5/11/2004	12:20	50	292	26.10	2.70	7.49	13.29	2.40	NA
Almaden Reservoir at outlet	E7-6	5/11/2004	10:25	Outlet	299	18.20	1.90	7.43	13.37	2.30	NA
Guadalupe Reservoir above thermocline	E7-1	6/10/2004	12:22	1	331	103.00	8.96	8.27	22.71	2.80	NA
Guadalupe Reservoir below thermocline	E7-2	6/10/2004	12:30	50	285	37.40	4.15	7.21	11.00	3.90	NA
Guadalupe Reservoir at outlet	E7-3	6/10/2004	13:41	Outlet	299	11.18	6.04	7.28	11.18	9.30	NA
Almaden Reservoir above thermocline	E7-4	6/10/2004	14:45	1	357	122.90	10.61	8.47	22.43	0.50	NA
Almaden Reservoir below thermocline	E7-5	6/10/2004	14:45	50	382	2.61	0.27	7.35	14.30	0.60	NA
Almaden Reservoir at outlet	E7-6	6/10/2004	16:45	Outlet	390	12.20	1.25	7.37	14.28	1.10	NA
Guadalupe Reservoir above thermocline	E7-1a	7/15/2004	7:40	1	339	99.4	8.3	8.29	24.46	3	86.5
Guadalupe Reservoir above thermocline	E7-1b	7/15/2004	7:40	1	339	99.4	8.3	8.29	24.46	3	86.5
Guadalupe Reservoir about 5' above TMC cusp	E7-7	7/15/2004	8:00	10	340	99.20	8.26	8.34	24.55	2.80	89.50
Guadalupe Reservoir at thermocline cusp	E7-8	7/15/2004	8:10	15	341	98.1	8.17	8.32	24.55	2.9	91.4
Guadalupe Reservoir about 5' below TMC cusp	E7-9	7/15/2004	8:20	20	356	53.5	4.67	7.44	22.33	1.5	110.9
Guadalupe Reservoir below thermocline -35'	E7-10	7/15/2004	8:40	35	245	3.6	0.37	7.05	14.34	3.8	126.4
Guadalupe Reservoir below thermocline -50'	E7-2	7/15/2004	8:45	50	211	14.3	1.55	7	11.76	3.3	133
Guadalupe Reservoir at outlet	E7-3	7/15/2004	9:50	Outlet	216	40.4	4.43	7.5	1.48	5.3	82.4
Almaden Reservoir above thermocline	E7-4	7/15/2004	12:00	1	353	NA	8.64	8.33	24.22	0	62.1
Almaden Reservoir about 5' above TMC cusp	E7-11	7/15/2004	12:00	20	351	98.2	8.26	8.3	23.96	0.1	74.8
Almaden Reservoir at thermocline cusp	E7-12	7/15/2004	12:05	25	351	85.4	7.34	8.09	23.01	0.4	82.9
Almaden Reservoir about 5' below TMC cusp	E7-13	7/15/2004	12:10	30	352	88	7.67	8	22.11	0.8	88.3

Table 3-5.(continued)
Field Parameters for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	Conductivity uS/cm	D.O. sat.% Saturation	D.O.m g/L	pH S.U.	Temperature °C	Turbidity NTUs	ORP milivolts
Almaden Reservoir below thermocline -35'	E7-14	7/15/2004	12:17	35	346	11.8	1.06	7.57	19.66	1.1	99.3
Almaden Reservoir below thermocline -50'	E7-5	7/15/2004	12:20	50	327	2.5	0.24	7.25	16.95	3.3	-17.5
Almaden Reservoir at outlet	E7-6	7/15/2004	13:18	Outlet	330	11.1	1.08	7.29	16.76	3.4	-64.7
Guadalupe Reservoir above thermocline	E7-1	8/2/2004	11:45	1	316	110.6	9.09	8.29	25.54	2.3	228.9
Guadalupe Reservoir about 5' above TMC cusp	E7-7	8/2/2004	12:00	10	316	102.6	8.41	8.08	25.52	2.1	256.3
Guadalupe Reservoir at thermocline cusp	E7-8	8/2/2004	12:05	15	318	99.1	8.12	8.06	25.5	2.2	263.8
Guadalupe Reservoir about 5' below TMC cusp	E7-9	8/2/2004	12:15	20	330	42.8	3.64	7.3	23.83	3.1	307.7
Guadalupe Reservoir below thermocline -35'	E7-10	8/2/2004	12:20	35	232	4.6	0.45	7	15.79	5.5	247
Guadalupe Reservoir below thermocline	E7-2	8/2/2004	12:25	50	198	2.5	0.26	6.89	12.76	3	174
Guadalupe Reservoir at outlet	E7-3	8/2/2004	10:14	Outlet	286.1	34	3.69	6.99	11.16	4	156.8
Almaden Reservoir above thermocline	E7-4a	8/2/2004	7:30	1	311	107.4	8.87	8.46	25.15	1.1	229.6
Almaden Reservoir above thermocline	E7-4b	8/2/2004	7:30	1	311	107.4	8.87	8.46	25.15	1.1	229.6
Almaden Reservoir about 5' above TMC cusp	E7-11	8/2/2004	7:40	25	308	101.6	8.38	8.4	25.13	0.9	269.9
Almaden Reservoir at thermocline cusp	E7-12	8/2/2004	7:50	30	298	59.4	5.06	7.87	23.49	0.5	309
Almaden Reservoir about 5' below TMC cusp	E7-13	8/2/2004	8:00	35	308	35.4	3.06	7.66	22.49	0.3	308
Almaden Reservoir below thermocline -40	E7-14	8/2/2004	8:20	40	307	3.2	0.28	7.44	21.23	0.6	314
Almaden Reservoir below thermocline	E7-5	8/2/2004	8:20	50	301	1.9	0.17	7.3	19.53	2.2	69
Almaden Reservoir at outlet	E7-6	8/2/2004	9:10	Outlet	303	8.7	0.81	7.33	19.02	3.2	28.6
Guadalupe Reservoir above thermocline	E7-1	8/12/2004	8:05	1	369	94.7	7.76	7.93	25.42	2	227
Guadalupe Reservoir below thermocline	E7-2a	8/12/2004	8:10	50	306	1.4	0.15	6.63	13.68	5.7	111.3
Guadalupe Reservoir below thermocline	E7-2b	8/12/2004	8:16	50	306	1.4	0.15	6.63	13.68	5.7	111.3
Guadalupe Reservoir at outlet	E7-3	8/12/2004	9:50	Outlet	291	1.1	3.46	6.61	12.44	2.5	261
Almaden Reservoir above thermocline	E7-4	8/12/2004	12:21	1	348	106	8.77	8.26	25.26	0.7	213.7

Table 3-5.(continued)
Field Parameters for Almaden and Guadalupe Reservoirs: Dry Season 2004

Location	Sample ID	Date Sampled	Time	Depth ft	Conductivity uS/cm	D.O. sat.% Saturation	D.O.m g/L	pH S.U.	Temperature °C	Turbidity NTUs	ORP milivolts
Almaden Reservoir below thermocline	E7-5	8/12/2004	12:03	50	378	1.5	0.12	7.09	21.61	1.4	87.5
Almaden Reservoir at outlet	E7-6	8/12/2004	13:13	Outlet	377	9.2	0.81	7.19	21.06	2.2	97.2
Guadalupe Reservoir above thermocline	E7-1	8/31/2004	12:45	1	396	106.1	8.7	8	25.53	1.4	49.7
Guadalupe Reservoir below thermocline	E7-2	8/31/2004	13:25	50	262	0.9	0.09	7.15	15.03	5.8	-58.6
Guadalupe Reservoir at outlet	E7-3	8/31/2004	14:30	Outlet	256	30.7	3.13	7.3	14.48	9.1	-45
Almaden Reservoir above thermocline	E7-4	8/31/2004	8:30	1	353	106	9.8	8.5	24.64	1.2	45.2
Almaden Reservoir below thermocline	E7-5a	8/31/2004	10:00	50	364	1.5	0.11	7.61	23.9	0.8	-100.5
Almaden Reservoir below thermocline	E7-5b	8/31/2004	10:00	50	364	1.5	0.11	7.61	23.9	0.8	-100.5
Almaden Reservoir at outlet	E7-6	8/31/2004	11:10	Outlet	368	1.1	0.95	7.62	23.75	1.8	-87.6

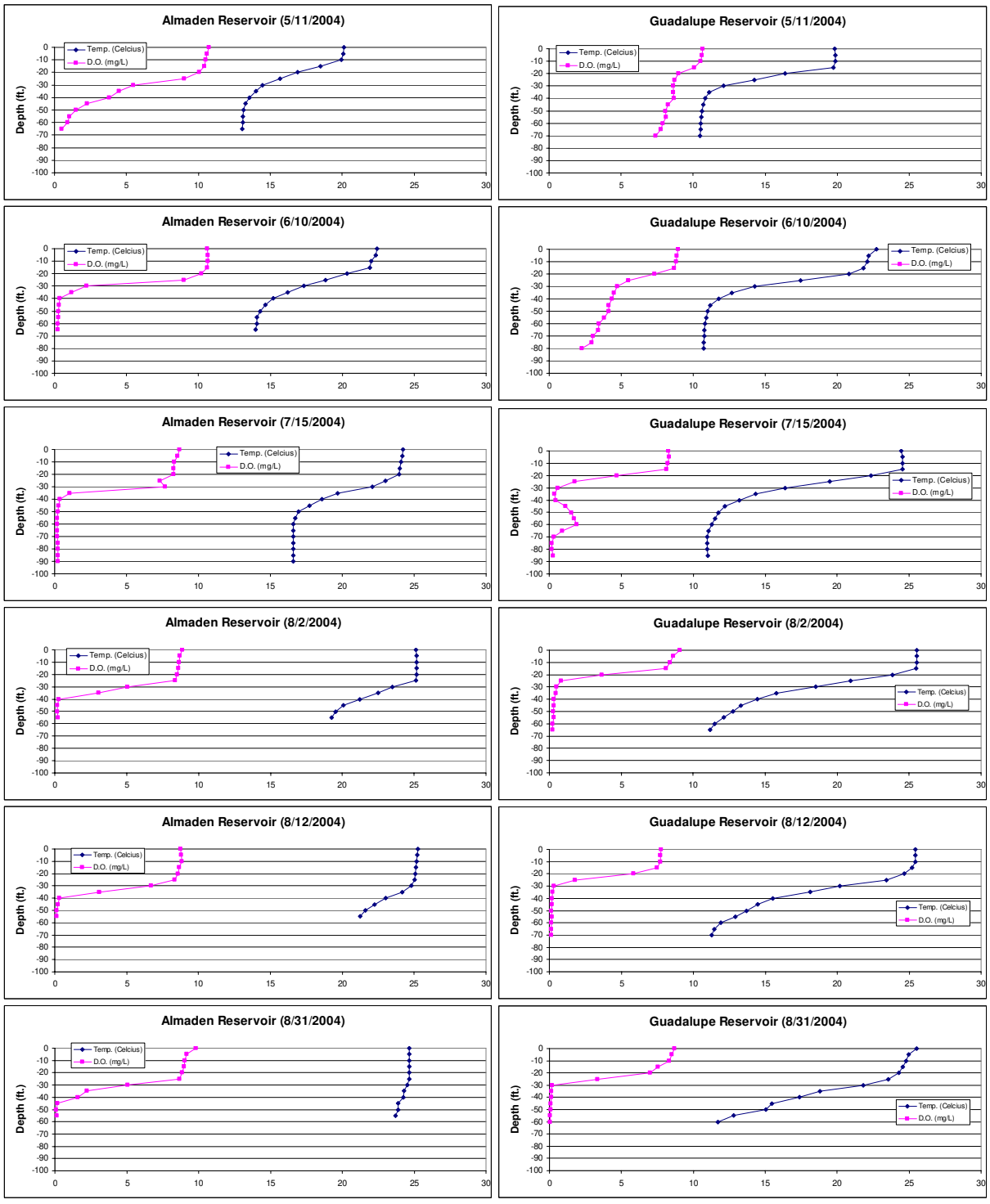


Figure 3-2 Temperature and Dissolved Oxygen Profiles for a) Almaden Reservoir and b) Guadalupe Reservoir

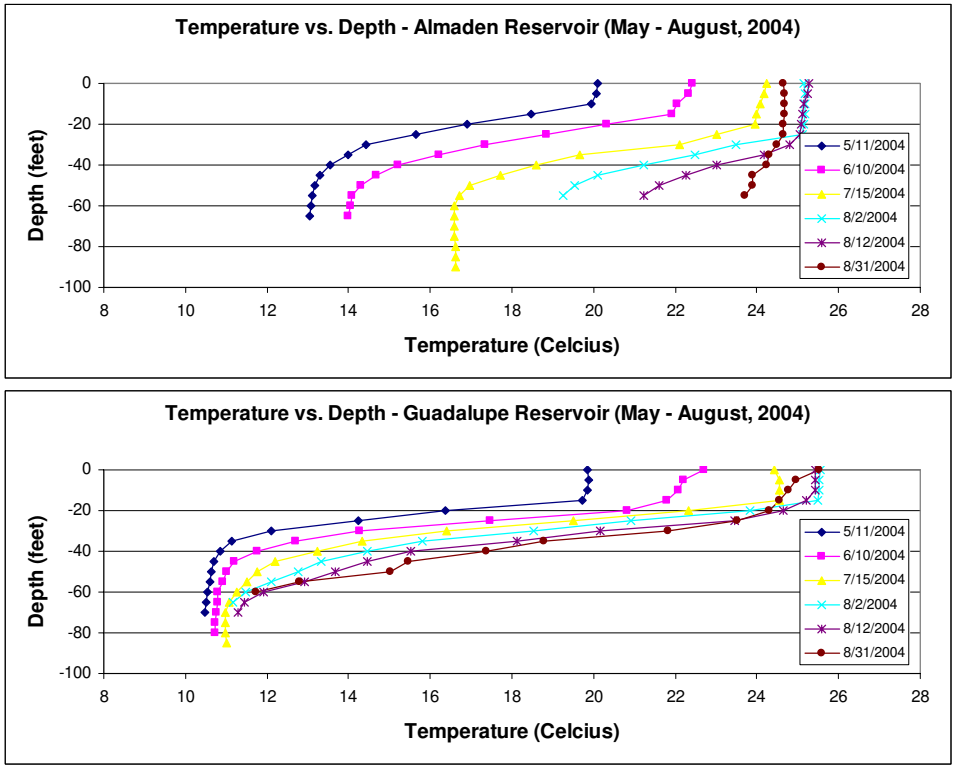


Figure 3-3. Composite Temperature Profiles for Almaden and Guadalupe Reservoirs

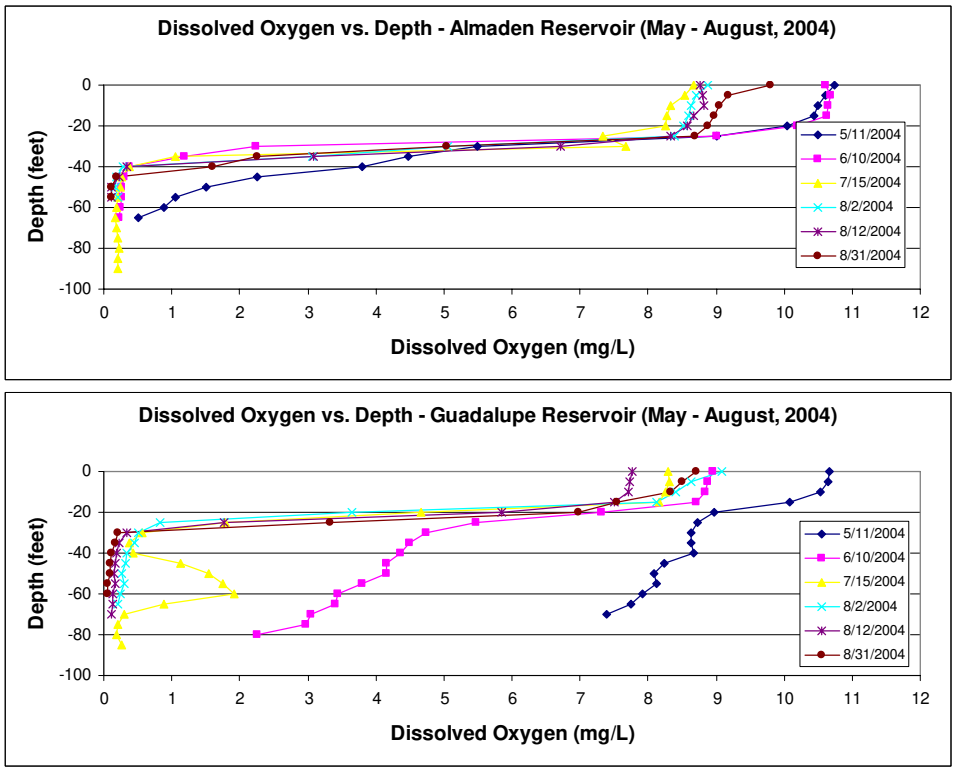


Figure 3-4. Composite Dissolved Oxygen Profiles for Almaden and Guadalupe Reservoirs

- **pH.** The pH of both reservoirs including outlets was near neutral to alkaline. In Almaden Reservoir, the pH ranged from 7.05 to 8.57 (Table 3-5). In Guadalupe Reservoir, the pH ranged from 6.61 to 8.34.

- **Dissolved Organic Carbon.** Both reservoirs have dissolved organic carbon indicative of productive impoundments, <1 to 3.5 mg/L. As seen in Figure 3-5, DOC concentrations were slightly higher in the epilimnion and hypolimnion of Guadalupe Reservoir. The low DOC concentration of <1 mg/L in the outlet of Guadalupe in July was not representative of summer conditions, since the next lowest concentration was 2.5 mg/L.

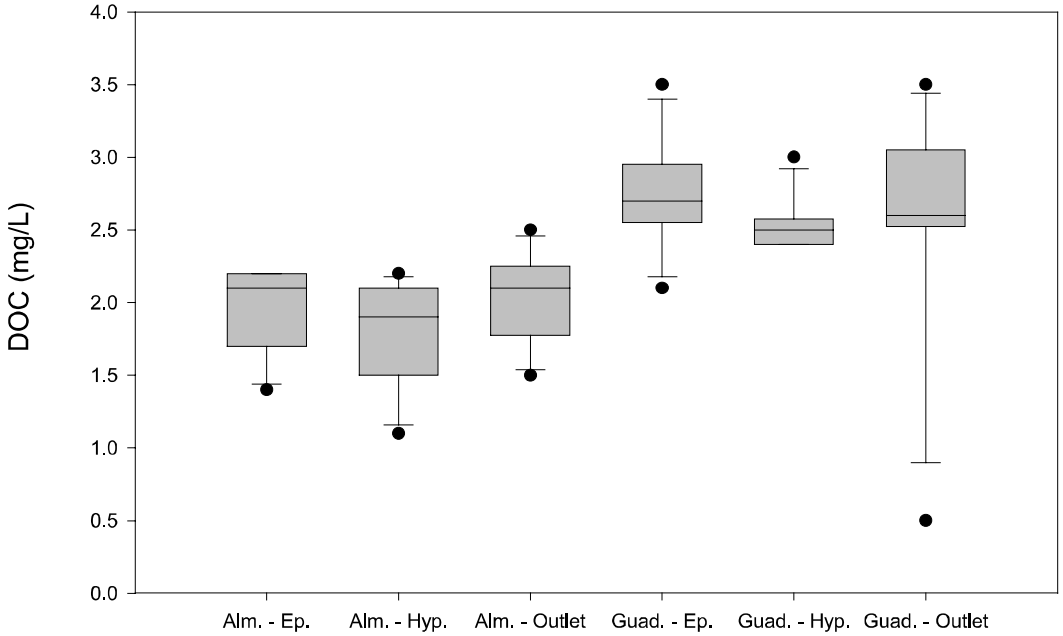


Figure 3-5. Comparison of DOC at different depths in Almaden and Guadalupe Reservoirs

- **Nutrients.** The nutrient data from the reservoirs are indicative of eutrophic ecosystems. The total phosphorus ranged from <0.03 to 0.59 mg/L in Guadalupe Reservoir and from <0.03 to 0.52 mg/L in Almaden Reservoir. Nitrate ranged from <0.05 to 0.19 mg/L in Guadalupe Reservoir; the higher concentrations were measured in May and June. Nitrate was detected in only one sample from the epilimnion of Almaden Reservoir, 0.07 mg/L on August 2, 2004; nitrate was not detected in the replicate sample at a detection of 0.05 mg/L. Nitrite was not detected in either reservoir at a detection limit of 0.05 mg/L. Total Kjeldahl nitrogen was detected in the hypolimnion and outlet samples of both reservoirs, ranging from <0.5 to 0.98 mg/L in Almaden Reservoir and from <0.5 to 0.7 mg/L in Guadalupe Reservoir. Ammonia nitrogen varied from <0.1 to 0.46 mg/L in Almaden Reservoir and <0.1 mg/L to 0.75 mg/L in Guadalupe Reservoir. Despite the relatively high nutrient levels, chlorophyll-a was not detected in any of the reservoir samples at a detection limit of 0.5 mg/L, which was higher than the requested detection

limit. Phytoplankton and zooplankton samples were collected from both reservoirs, but the results are not yet available. It is expected that these data will provide useful information, confirming that the chlorophyll-a is sufficient for biota.

- **Sulfate and Sulfide.** The range of sulfate in the two reservoirs was similar, 12 to 18 mg/L in Almaden and 12 to 19 mg/L in Guadalupe. Higher sulfate was measured in the epilimnion zones of both reservoirs, while the lowest sulfate was measured in the outlets, as seen in Figure 3-6. Sulfide was present in both reservoirs at similar levels, as shown below. Higher values were noted in the hypolimnion.

  Almaden Reservoir
  - epilimnion <0.01 to 0.015 mg/L
  - hypolimnion <0.01 to 0.084 mg/L
  - outlet <0.01 to 0.17 mg/L, and

  Guadalupe Reservoir
  - epilimnion <0.01 to 0.021 mg/L
  - hypolimnion <0.01 to 0.14 mg/L
  - outlet <0.01 to 0.04 mg/L.

  The combination of higher sulfate in the epilimnion and higher sulfide in the hypolimnion and outlets indicates that sulfate reduction is occurring. Hydrogen sulfide odors and sometimes a white precipitate were observed in the outlets at the time of sampling, particularly at the Almaden Reservoir outlet.

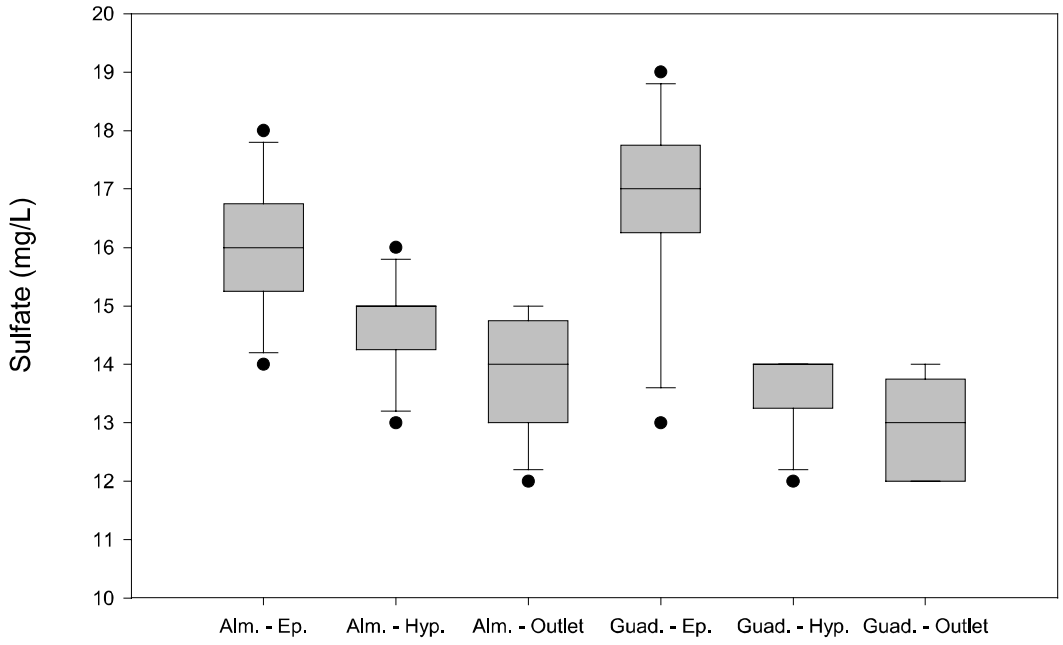


Figure 3-6. Comparison of Sulfate in Reservoirs

3.3 COMPARISON OF MERCURY RESULTS FOR RESERVOIRS

The concentrations of total and methylmercury species and suspended solids in the reservoir outlets are compared in Figure 3-7. The highest concentrations of total and dissolved mercury and methylmercury were found in the outlet from Guadalupe Reservoir on August 31, 2004, partly due to the higher suspended solids of 11.5 mg/L. Figure 3-7 shows a clear increase in methylmercury concentrations over the summer in both reservoirs. Methylmercury concentrations were higher in both reservoirs than in the earlier part of the summer, indicating that following the onset of stratification, methylmercury concentrations continually increase. Methylmercury concentrations were also significantly higher in the late summer than in the wet season.

When total mercury and methylmercury concentrations in the outlets are plotted versus suspended solids, there is a clear distinction between the dry and wet weather samples, as seen in Figure 3-8a for Almaden Reservoir and Figure 3-8b for Guadalupe Reservoir. In all cases, the suspended solids were higher in the wet season samples. For methylmercury, the concentrations were higher in the summer, especially in Almaden Reservoir. There was less correlation with suspended solids and methylmercury than with suspended solids and total mercury.

The concentrations in the epilimnion and hypolimnion are compared in a series of box plots: for total mercury (Figure 3-9), dissolved mercury (Figure 3-10) and for methylmercury (Figure 3-11). These plots show higher total mercury concentrations in Guadalupe Reservoir compared to Almaden Reservoir. The dissolved mercury was higher in the hypolimnion and outlet of Guadalupe Reservoir, while the concentrations in the epilimnion were similar for both reservoirs. Median methylmercury concentrations were higher in the outlet of Almaden Reservoir, although the 75th percentile and maximum concentrations were higher in Guadalupe Reservoir. Part of the difference may be due to the greater variability and higher concentrations of suspended solids in Guadalupe Reservoir, as seen in Figure 3-12. The higher suspended solids in Guadalupe Reservoir were measured in the hypolimnion and outlet samples. The box plots for methylmercury indicate that concentrations were lower in the epilimnion than hypolimnion in both reservoirs. This finding is consistent with production in the hypolimnion, as indicated by the increasing concentrations over the summer (Figure 3-13). The methylmercury concentrations in the epilimnion were low and relatively constant, as seen in Figure 3-14a for Almaden Reservoir and in Figure 3-14b for Guadalupe Reservoir. In the hypolimnion of both reservoirs, as the dissolved oxygen decreased to less than 1 mg/L the methylmercury increased. The methylmercury concentrations continued to increase in the deeper part of the hypolimnion, as measured in the outlets of both reservoirs. Methylmercury production rates were estimated as discussed in Section 4.

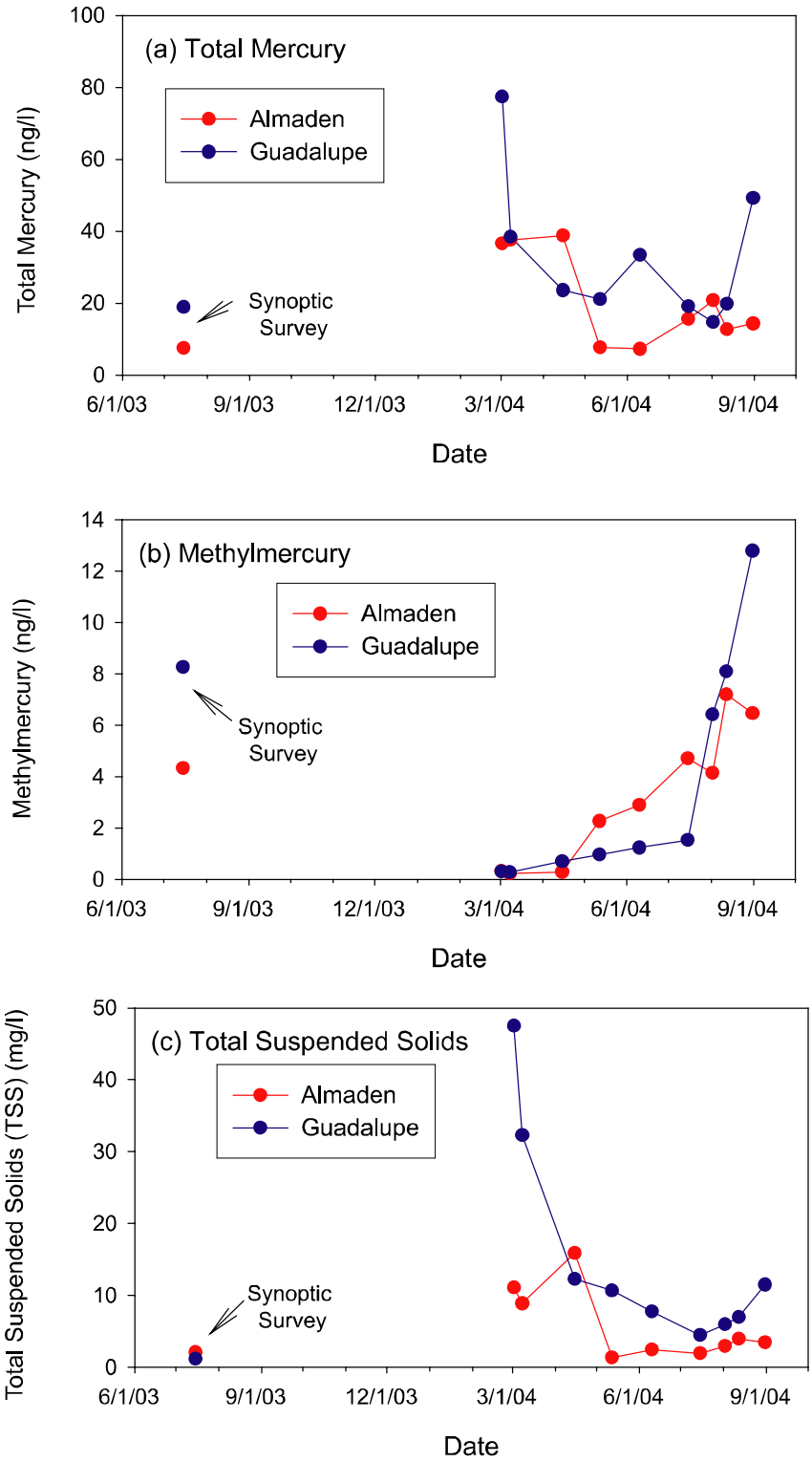


Figure 3-7. (a) Total mercury, (b) methylmercury, and (c) TSS in Almaden and Guadalupe Reservoir Outlets as measured during the synoptic Survey in 2003 and during the wet and dry season sampling in 2004.

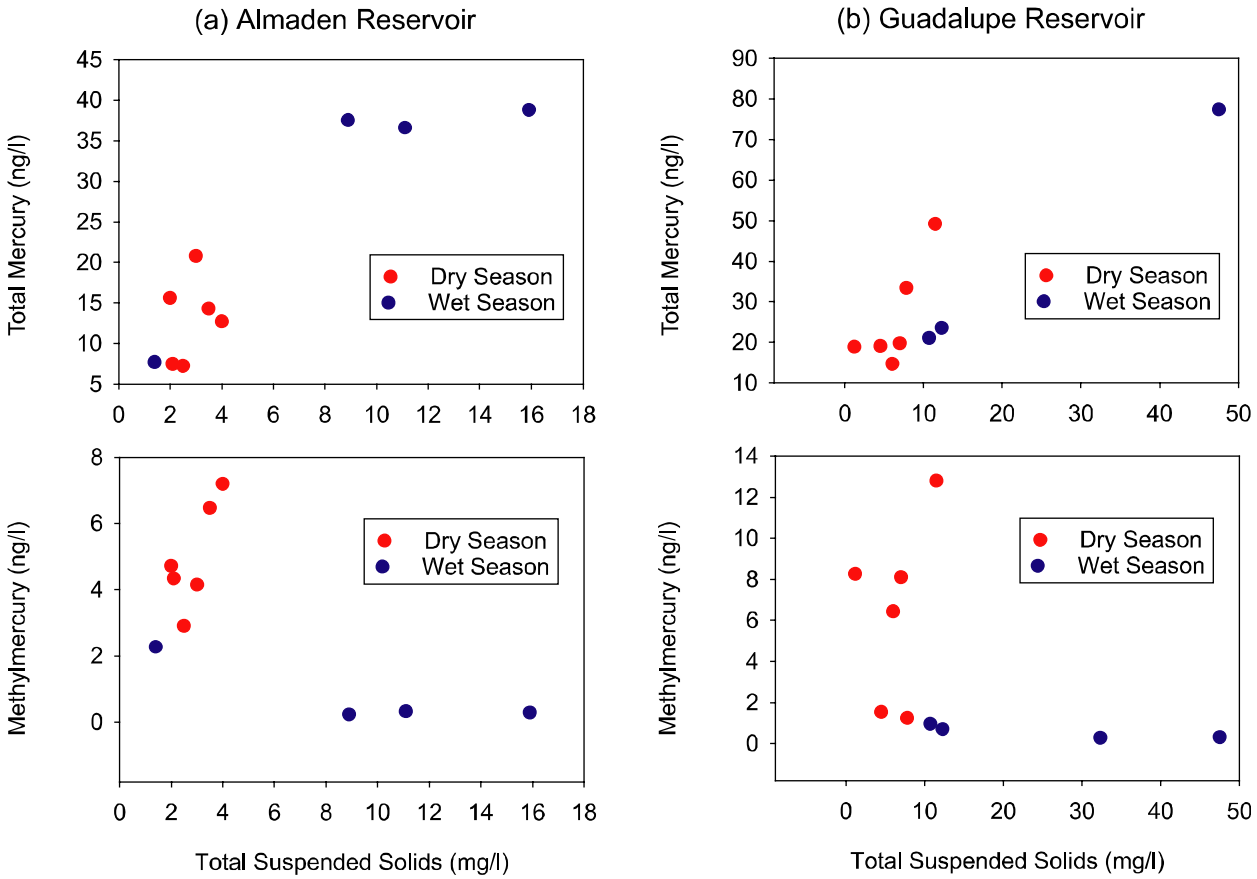


Figure 3-8. Total and Methylmercury versus Suspended Solids in a) Almaden Reservoir Outlet and b) Guadalupe Reservoir Outlet.

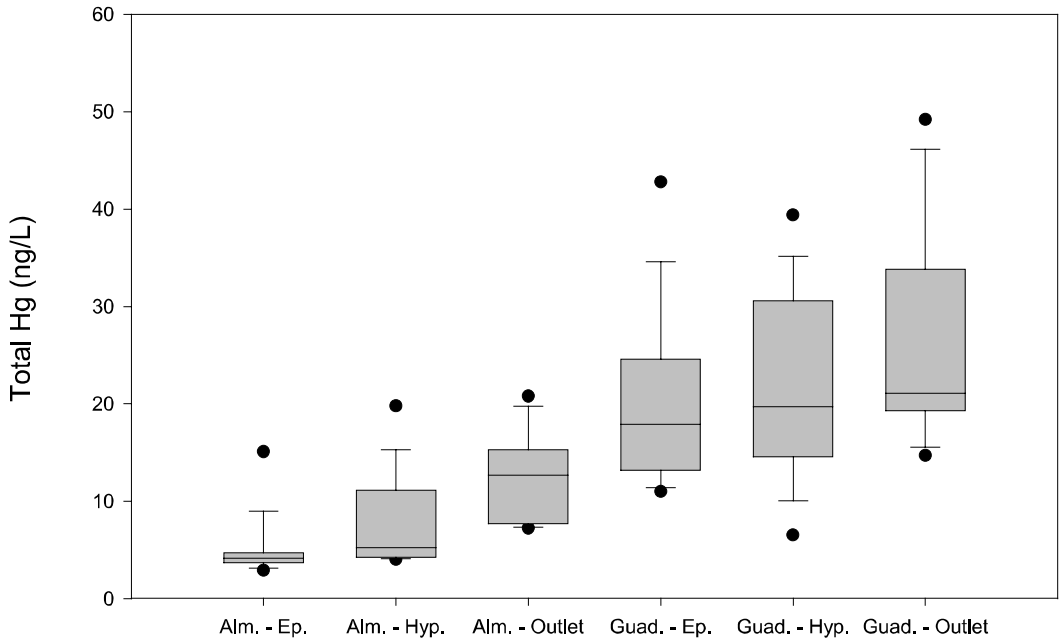


Figure 3-9. Comparison of Total Mercury in Almaden and Guadalupe Reservoirs

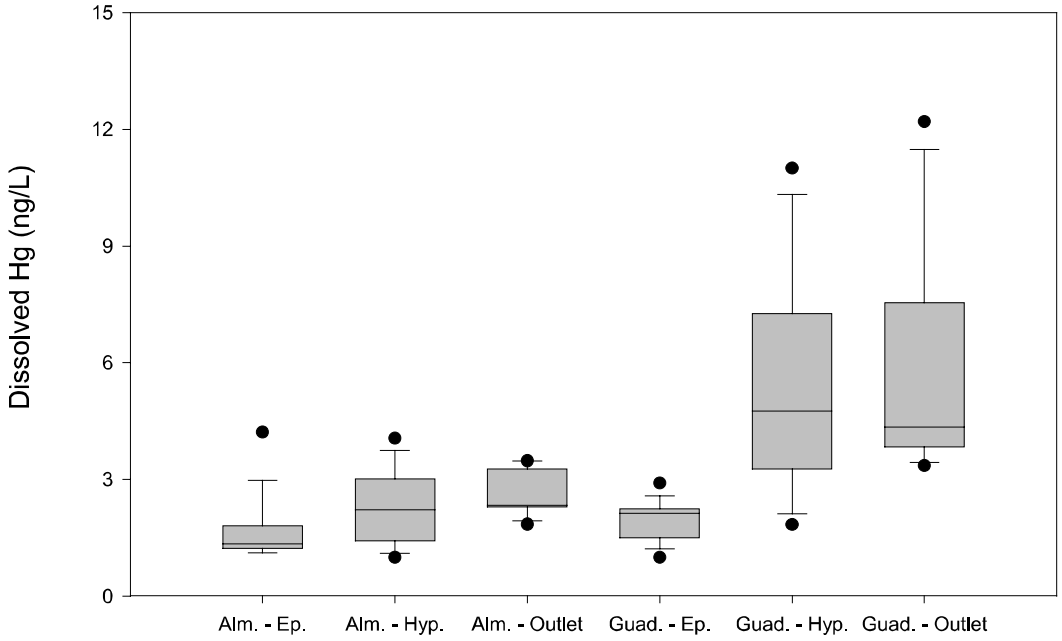


Figure 3-10. Comparison of Dissolved Mercury in Almaden and Guadalupe Reservoirs

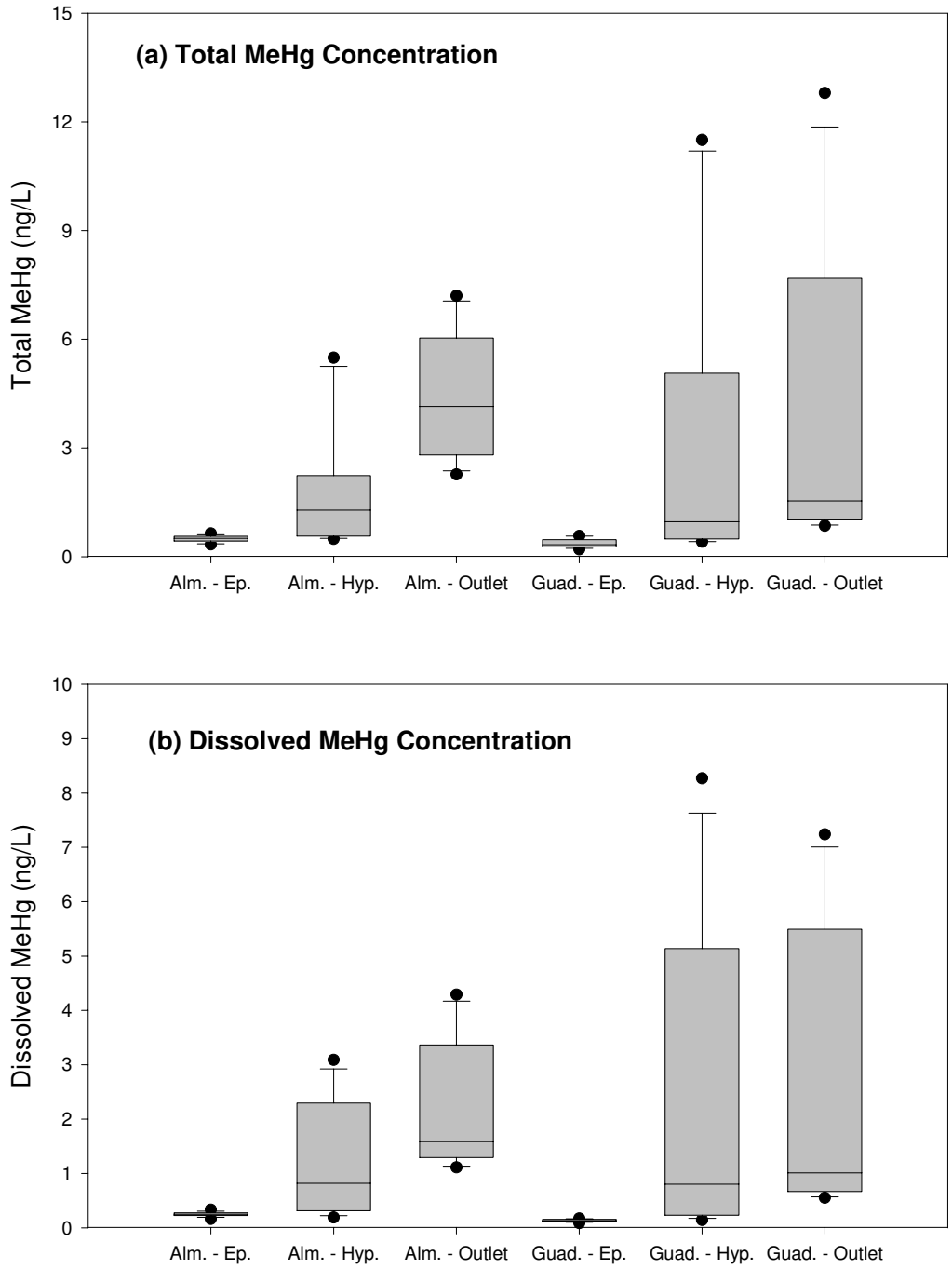


Figure 3-11. (a) Total (unfiltered) and (b) dissolved (filtered) Methylmercury in Almaden and Guadalupe Reservoirs.

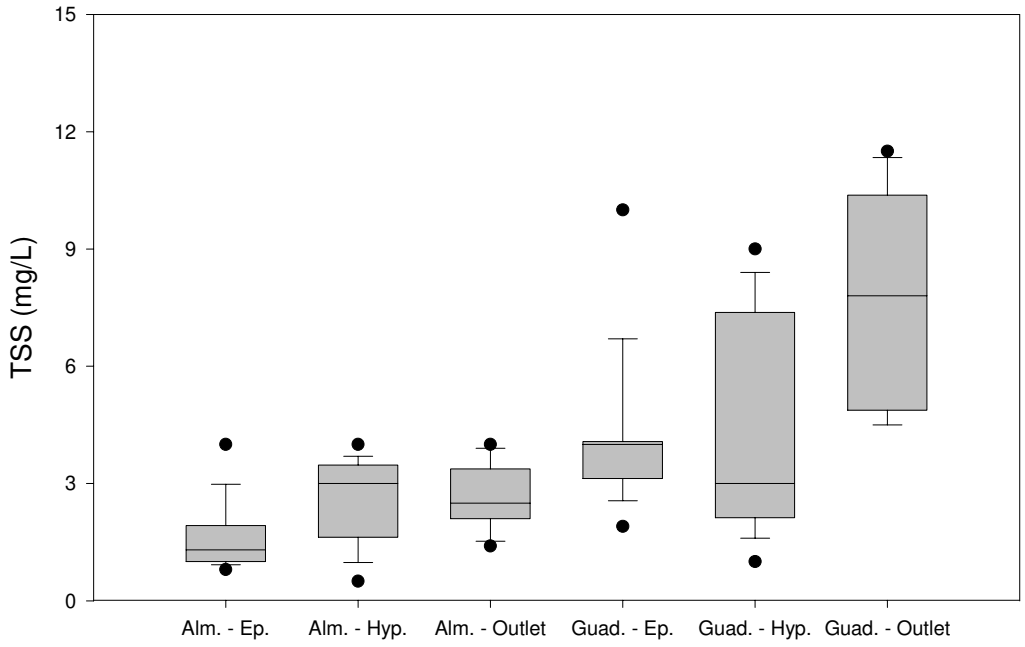
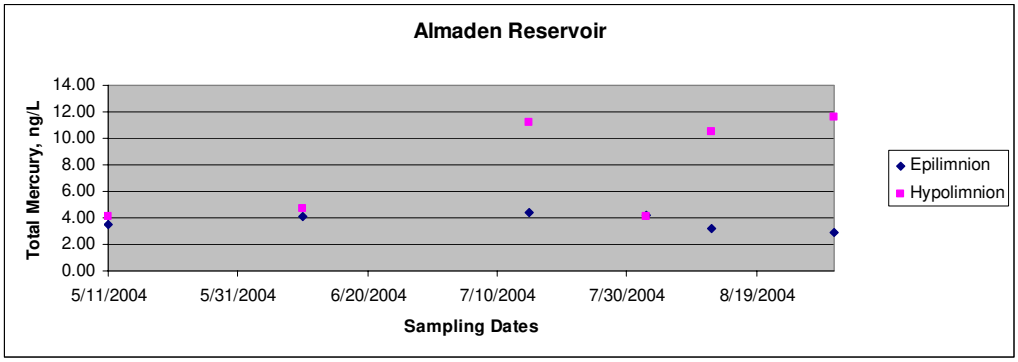
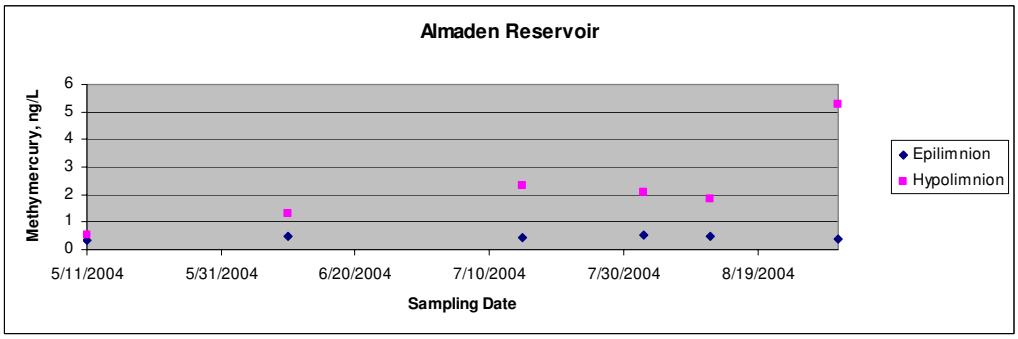
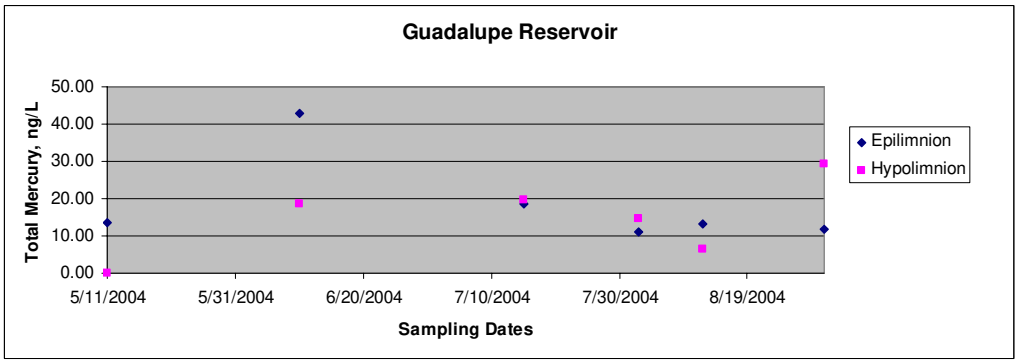


Figure 3-12. Suspended Solids Concentrations in Almaden and Guadalupe Reservoirs







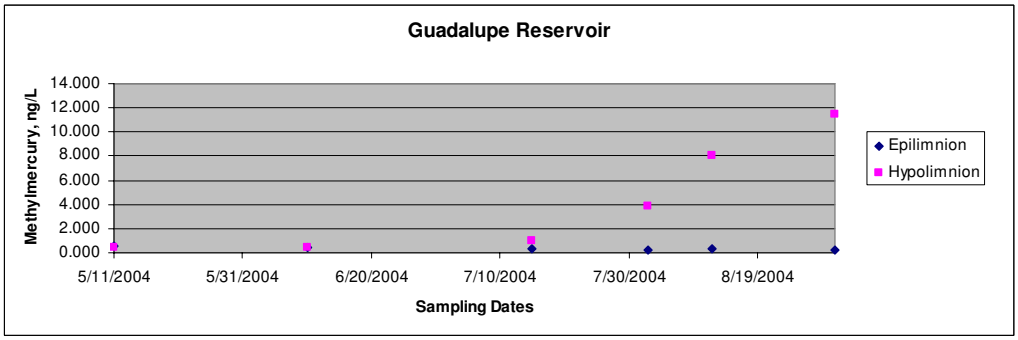
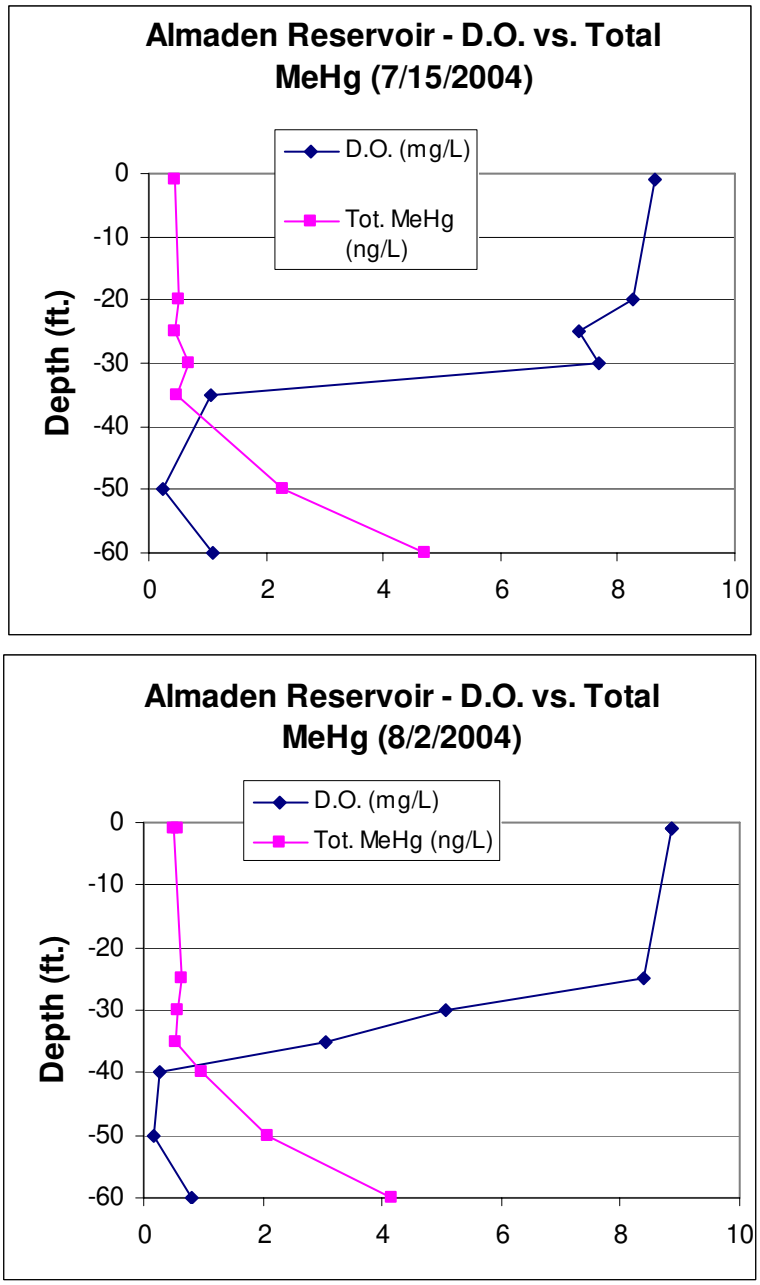
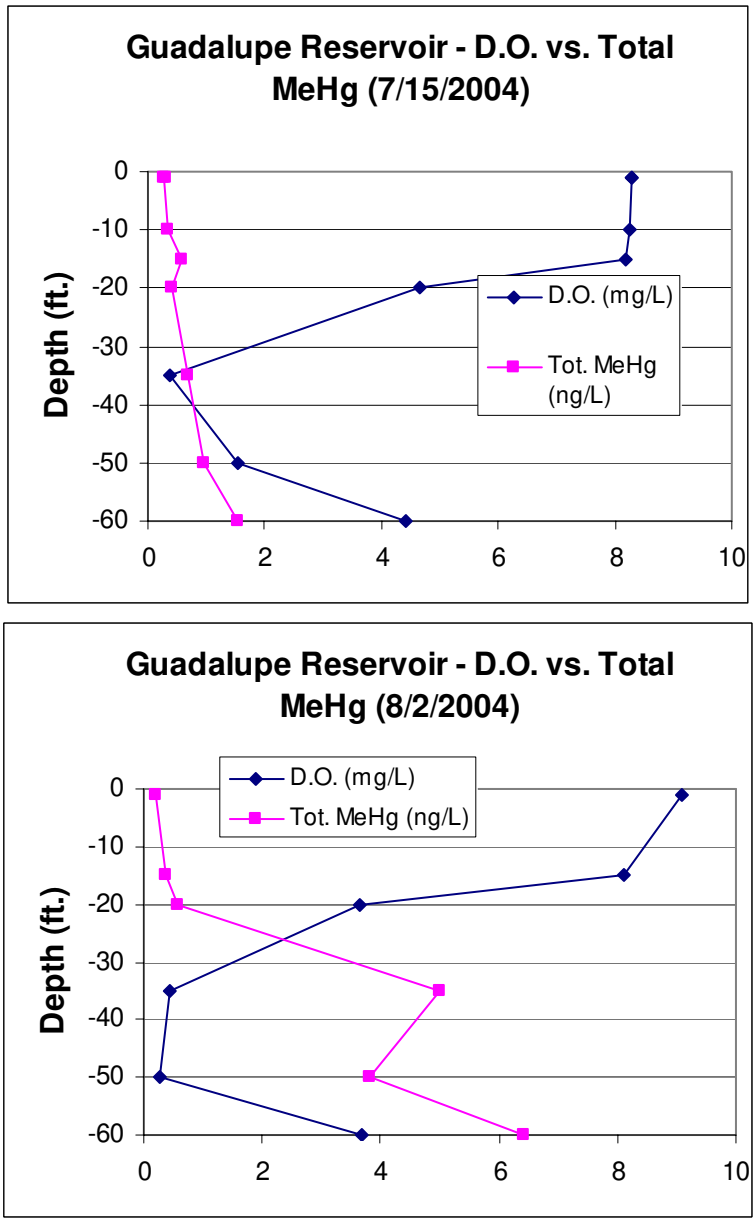


Figure 3-13. Change in Mercury Concentrations in Dry Season



Outlet concentrations shown at depth of 60 feet on plots.

Figure 3-14a.DO and Methylmercury Profiles in Almaden Reservoir.



Outlet concentrations shown at depth of 60 feet.

Figure 3-14b. DO and Methylmercury Profiles in Guadalupe Reservoir.

3.4 Assessment of Data Quality and Constraints

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004c, 2003d) were followed. The QA/QC results are discussed in Appendix B. The mercury data are usable for data analyses based on the QA/QC criteria. One constraint with respect to other water quality parameters is that the laboratory could not achieve the desired low detection limit for chlorophyll-a data. The other nutrient data showed that both reservoirs are productive, as is expected to be confirmed by analysis of the mass of phytoplankton and zooplankton in the water column of both

reservoirs. The phytoplankton and zooplankton data were not available at the time of this report.

3.5 COMPARISON WITH PREVIOUS DATA

The two reservoir outlets were sampled for the Synoptic Survey in July 2003 and in March and April 2004 for the Wet Weather Survey. The Almaden Reservoir outlet has been sampled thirteen times between June 2, 2003 and August 19, 2004 by Light, Air, and Space Construction (LAS) for SCVWD. These data are provided in Tables 3-6 and 3-7, respectively.

As seen in Figure 3-7, the total and methylmercury concentrations in the outlet of Guadalupe Reservoir were similar in July 2003 to July 2004. For Almaden Reservoir, the methylmercury concentrations were similar in the outlets for July 2003 and 2004, while the total mercury was lower in July 2003 (Table 3-5). In both reservoirs, the methylmercury concentrations were higher in the epilimnion in July 2003 than in July 2004. The deeper samples from the epilimnion at 10 to 25 feet in July 2004 were also less than the July 2003 samples. One possible reason for the difference is the lower temperature in July 2004, 24°C versus 26°C. Another difference in the two years is that the reservoir was drawn down more over the summer in 2004 than in 2003, as discussed in Section 4.

There was a small increase in methylmercury concentrations in the 1-foot sample in Almaden Reservoir from 0.336 ng/L in May 2004 to 0.58 ng/L in early August, but this was followed by a decline back to 0.37 ng/L at the end of August. Thus, this change suggests variability rather than production in the epilimnion. The higher methylmercury concentrations in the 10-foot samples from vegetated areas in both reservoirs in July 2003 (2.1 to 3.0 ng/L) may indicate localized production. Samples from vegetated areas were not collected in 2004. The initial increasing trend in methylmercury concentrations in the 1-foot samples was not observed in Guadalupe Reservoir, where the concentrations decreased from 0.56 ng/L in May 2004 to 0.20 ng/L in early August, followed by a slight increase to 0.32 ng/L in mid-August and 0.27 ng/L in late August. These results also suggest variability, rather than a change in production within the epilimnion.

The results from the LAS sampling of the outlet from Almaden Reservoir showed higher methylmercury concentrations in the August 2003 samples (9.7 to 10.5 ng/L) than the August 2004 samples (7.0 to 6.8 ng/L), as shown in Table 3-7. The LAS samples consist of two field replicates of the outlet on each date. As expected, the methylmercury concentrations were lower in the samples taken in the wet season than in the dry season (Figure 3-15). The LAS results for methylmercury were comparable for the mid-August 2004 outlet samples: 7.0 to 6.8 ng/L on August 19th, compared to 7.2 ng/L on August 12th and 6.5 ng/L on August 31st for the Tetra Tech samples. However, the LAS results for methylmercury for the earlier dates in May and June were considerably lower, although the total mercury concentrations were higher.

Table 3-6.
Previous Suspended and Mercury Data for Almaden and Guadalupe Reservoirs

						Total Mercury		Methyl Mercury	
Location	Sample ID	Date Sampled	Time	Depth ft	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Unfiltered ng/L	Filtered ng/L
Almaden Res shallow	#21T	7/30/2003	8:55	1	0.8	5.64	2.26	1.36	0.61
Almaden Res deep	#21 B	7/30/2003	9:30	40	1.6	5.93	2.25	1.05	0.556
Almaden Res shallow	#22	7/302003	11:05	10	1.1	6.59	1.75	1.5	0.414
Almaden Res shallow, veg.	#22 V	7/30/2003	17:30	10	1.2	6.75	3.26	2.98	1.06
Guadalupe Res shallow	#19 T	7/31/2003	12:00	1	1.2	10.64	3.31	1.05	0.491
Guadalupe Res deep	#19 B	7/31/2003	12:35	40	1.1	7.56	2.91	1.63	0.743
Guadalupe Res shallow	#20	7/31/2003	13:20	10	1.9	17.9	4.62	1.67	0.744
Guadalupe Res shallow, veg.	#20V	7/31/2003	13:30	10	1.7	19.96	1	2.14	0.595

						Total Mercury		Methylmercury	
Location	Sample ID	Date Sampled	Time	Depth ft	TSS mg/L	Unfiltered ng/L	Filtered ng/L	Unfiltered ng/L	Filtered ng/L
Almaden Reservoir Outlet	E1-01	3/2/2004	12:00	Surface	11.1	36.6	8.25	0.328	0.149
Almaden Reservoir Outlet	E1-01	3/8/2004	14:00	Surface	8.9	37.5	5.56	0.233	0.156
Almaden Reservoir Outlet	E1-01	4/14/04	10:10	Surface	15.9	38.79	3.59	0.29	0.114
Guadalupe Reservoir Outlet	E1-08	3/2/2004	13:35	Surface	47.5	77.4	6.25	0.319	0.152
Guadalupe Reservoir Outlet	E1-08	3/8/2004	14:50	Surface	32.3	38.4	5.41	0.287	0.149
Guadalupe Reservoir Outlet	E1-08	4/14/04	9:18	Surface	12.3	23.56	4.82	0.704	0.179

Data are from Synoptic Survey in 2003 and Wet Weather Survey in 2004.

Table 3-7.
LAS Data for Almaden Reservoir 2003-2004

	Res Level	Outlet Flow	Samples 2 repls	Temp deg C	pH	DO in Outlet mg/L	DO in Res mg/L	Conductivity mmhos/cm3	Turbidity Ntu	TSS mg/L	Total Hg ng/L	Diss Hg ng/L	MeHg ng/L	DOC mg/L	Sulfate mg/L	Sulfide mg/L	Chloride mg/L	Total Fe mg/L	Diss Fe mg/L
6/2/2003			A	14.3	7.8	10.78	7.9	39	2	<10	14	14	<0.07	1.3	18	<1	12	<0.1	<0.1
9:49 AM	608.06	3.8	B				35 ft				31.4	29	<0.07	1.7	18	<1	11	<0.1	<0.1
7/17/2003			A	22.1	7.5	10.76	0.68	0.516	1	13	8.67	6.27	2.31	1.4	NA	NA	NA	NA	NA
11:45 AM	605.46	3.95	B				33 ft			<10	28.6	6.71	1.88	1.4	NA	NA	NA	NA	NA
8/18/2003			A	21.2	7.64	9.68		0.46	1	<10	10.2	9.36	10.5	2.2	13	NA	6.5	0.19	0.17
5:20 PM	602.25	4.62	B								10.7	9.53	9.72	2.4	13	NA	6.2	0.19	0.17
10/1/2003			A	21.9	7.97	NA	6.98	0.45	19	<10	16.7	14	2.27	1.9	17	NA	<10	0.34	0.11
2:06 PM	595.99	5.6	B				31 ft				14.8	14.4	2.08	2.8	20	NA	<10	0.16	0.36
10/31/2003			A	18.4	7.07	6.87L	4.93	0.405	23	14	31.1	34.1	0.604	2.4	15	NA	8.1	NA	NA
1:02 PM	590.08	4.8	B				25 ft			10	32.3	31.3	0.491	2.3	15	NA	9.6	NA	NA
12/8/2003			A	12.8	NA	NA	6.04	0.515	33	25	45.9	42.1	0.459	1.9	14	NA	12	NA	NA
2:56 PM	583.62	2.9	B				12 ft			31	44.8	48.5	0.401	1.9	22	NA	14	NA	NA
1/8/2004			A	10.9	7.29	8.46 L	6.42	0.28	52	12	55.2	39.6	0.437	3.1	15	NA	<10	NA	NA
9:49 AM	583.41	4.45	B				40 ft			11	51.6	35.6	0.389	3	16	NA	<10	NA	NA
3/3/2004			A	13.2	8.5	13.49	7.68	0.321	42	<10	24.6	21.1	0.181	1.6	12	NA	11	NA	NA
4:45 PM	602.58	4.81	B				39 ft			<10	25.8	18.2	0.173	3.7	14	NA	<10	NA	NA
4/6/2004			A	13.1	8.37	12.21	4.61	0.348	45	11	<200*	<200*	0.226	3.1	15	NA	10	NA	NA
10:00 AM	606.25	5.39	B				45 ft			11	<200*	<200*	0.197	3.2	14	NA	10	NA	NA
5/11/2004			A	17.8	7.54	10.13	0 at 45-46 ft	0.509	2	<10	9.06	5.25	0.065	<0.8	2	NA	1.2	NA	NA
12:00 PM	608.33	5.39	B				0 at 46 ft			<10	12.1	5.3	0.061	<0.8	22	NA	14	NA	NA
6/15/2004			A	20.2	8.61	11	0 at 28 & gr	0.407	10	<10	7.21	1.96	0.04	1.9	19	NA	12	NA	NA
11:25 AM	606.58	5.6	B				0 at 43 ft			<10	10.3	4.91	0.047	<1.2	21	NA	13	NA	NA
7/15/2004			A	21.4	12.82	12.3	0 at 24 & gr	0.396	42	<10	10.7	5.97	0.078	<0.8	16	NA	13	NA	NA
4:55 PM	603.17	13.1	B				0 at 39 ft			<10	14.4	8.83	0.06	<0.8	15	NA	13	NA	NA
8/19/2004			A	17	7.91	13.77	9.16 at 14 ft	0.279	12	<10	8.89	2.63	7.05	1.8	16	NA	11	NA	NA
3:45 PM	598	5.39	B				**			<10	4.2	2.97	6.78	1.9	16	NA	11	NA	NA

*Analyzed using EPA Method 7470A instead of 1631, due to lost samples by courier
Data collected by Light, Air, & Space Co. for SCVWD.
Spillway elevation is 608.7 ft at Almaden Reservoir.
gr means greater than indicated depth
**Measured inside boom where depth was only 15 feet.

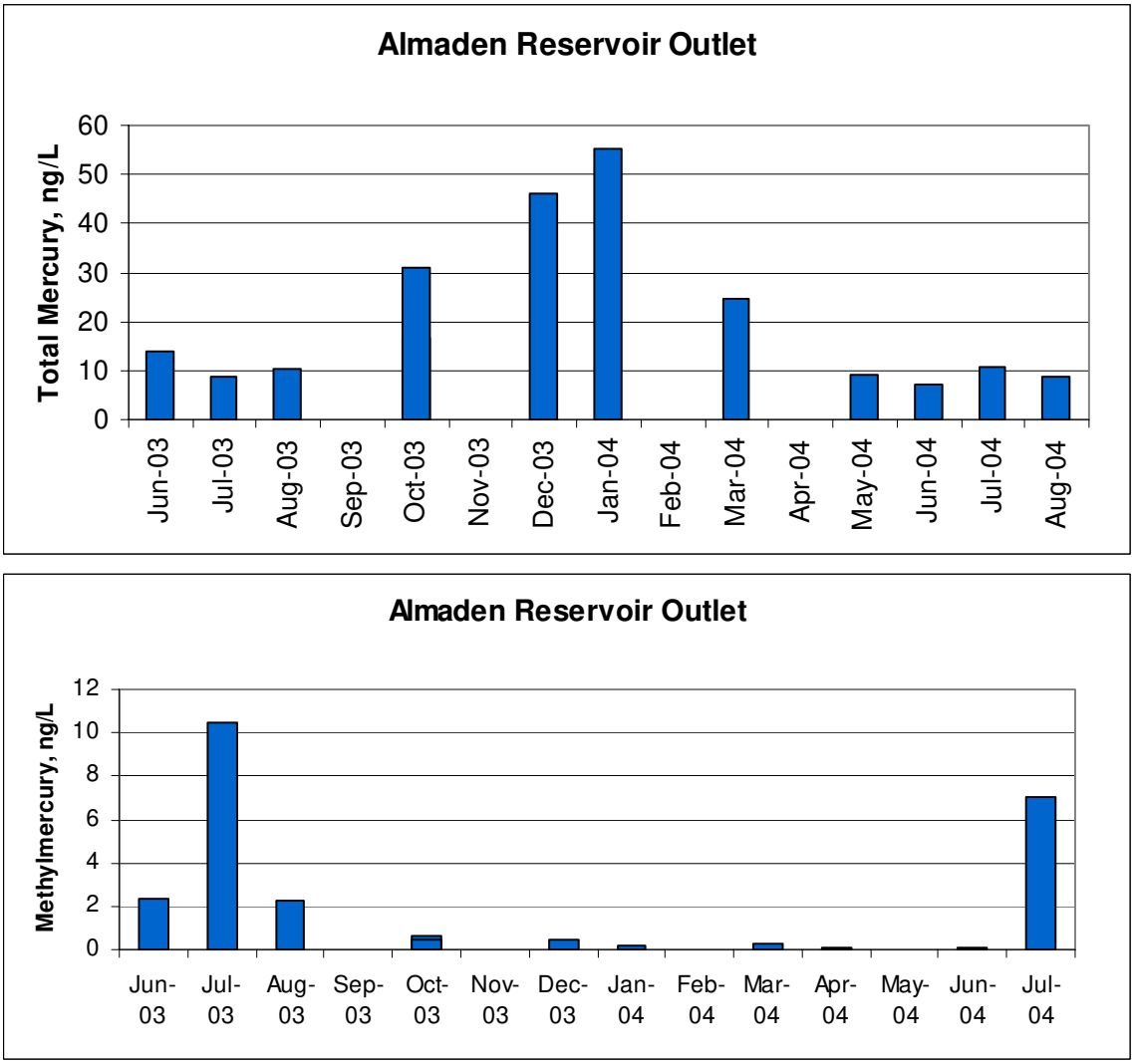


Figure 3-15. Total and Methylmercury in Almaden Reservoir Outlet from June 2003 to August 2004 (LAS, 2004)

The two reservoir outlets were sampled by Tetra Tech in the wet season between February and April 2004. The dry season total mercury concentrations for the Almaden outlet in 2003 and 2004 ranged from 7.2 ng/L to 20.8 ng/L, compared to the wet season range from 36.6 to 38.8 ng/L. The dry season results for the outlets are clearly seen as distinct in plots of total mercury and methylmercury versus suspended solids, due to the higher suspended solids in the wet season (See Figures 3-8a and b). The total mercury concentrations for the LAS wet season samples ranged from 24.6 ng/L in March 2004 to 55.2 ng/L in January 2004, compared to 4.2 to 32.2 ng/L for the dry season. Thus, total mercury concentrations were higher in the wet season for both data sets. In contrast, methylmercury concentrations for the Almaden outlet were higher in the dry season (2.27 ng/L to 7.2 ng/L) than in the wet season (0.23 to 0.29 ng/L). The LAS samples for methylmercury concentrations ranged from 0.04 ng/L to 10.5 ng/L in the dry season, compared to 0.17 ng/L to 0.46 ng/L in the wet season.

The total and methylmercury concentrations between the dry and wet seasons also differed for Guadalupe Reservoir. Total mercury concentrations varied from 23.6 ng/L to 77.4 ng/L in the wet season, compared to 14.7 to 49.2 ng/L in the dry season. Methylmercury concentrations varied from 0.29 ng/L to 0.7 ng/L in the wet season, compared to 0.97 to 12.8 ng/L in the dry season. Thus, both reservoirs exhibit the same pattern with higher methylmercury concentrations in the late summer and higher total mercury concentrations in the wet season.

3.6 KEY FINDINGS

Data on total and methylmercury collected during the dry season, 6 times over a fourteen-week period, demonstrated clearly the gradual buildup of methylmercury in Almaden and Guadalupe Reservoirs. Much of the methylmercury generated in the reservoirs was produced in the hypolimnion, which is where the withdrawals for downstream supply take place. The most significant production of methylmercury occurred when the hypolimnion was largely anoxic (dissolved oxygen levels less than 1 mg/l).

It appears from these measurements that there are some differences in the quantity of methylmercury produced among the two reservoirs studied (Guadalupe produces more methylmercury than Almaden). Data collected on ancillary parameters (e.g., pH, sulfate, sulfide, nutrients) did not provide a clear explanation for these differences. In future sampling, sediment mercury and methylmercury measurements need to be made to better understand these differences.

4.0 ESTIMATION OF DRY SEASON INTERNAL LOADS AND MERCURY EXPORTS FROM RESERVOIRS

Using the data collected on total mercury and methylmercury during the dry-weather phase of this study, described in detail in the previous chapter, we calculated the internal loads and downstream exports of mercury from the two most contaminated reservoirs, Guadalupe and Almaden Reservoir.

Load calculations for mercury over the period of interest must consider the measured mercury concentrations and the reservoir stored-water volumes, both of which change over time. The primary data source for these calculations was the monthly to biweekly sampling of Almaden and Guadalupe Reservoirs conducted between May and August of 2004. These months are associated with warm temperatures, thermal stratification in reservoirs, and the occurrence of enhanced methylation, particularly in the hypolimnion. The relevant mercury data collected over this period have been summarized in Chapter 3 and are identified in selected plots that follow. Besides the mercury concentration data, other data required for the load calculations are the volumes of water stored in the reservoir in the hypolimnion and the epilimnion, and the outflows from the reservoirs. The depth to the hypolimnion was estimated from the temperature and DO profiles that were taken during the mercury sampling and described in Chapter 3. The calculation of the hypolimnion and epilimnion volume was based on detailed bathymetric maps of the reservoirs. The reservoir stored water volumes and outflows were obtained from automated gages that are associated with SCVWD's online ALERT system (http://alert.valleywater.org). Details of the load calculations and the estimated internal loads and exported loads are summarized in this section.

4.1 RELATING STAGE AND RESERVOIR STORED WATER VOLUME

Because there are distinct differences in the concentrations of mercury species between the hypolimnion and the epilimnion, the volumes of these two compartments must be estimated separately to quantify the mass of mercury associated with each compartment. This is done using the elevation of the upper surface of the hypolimnion and relating this elevation to the stored water volume. The volume of water stored in Guadalupe and Almaden reservoirs as a function of stage was calculated using data on the bathymetry of the two reservoirs. The bathymetry data for these reservoirs were made available to us in electronic form by the SCVWD. The computer program SURFER™ was used to estimate the volume associated with different surface water elevations in the reservoirs. The relationship between stored water and water elevation for the two reservoirs in shown in Figure 4-1. The best-fit non-linear regression lines through these data are also shown in these plots. These regression equations were used to estimate the volume of water corresponding to the hypolimnion or the epilimnion as described below.

4.2 ESTIMATING THE DEPTH AND VOLUME OF THE HYPOLIMNION

Data on dissolved oxygen and temperature collected at 5-foot depth increments were used to identify the depth separating the hypolimnion and the epilimnion. This depth is usually associated with an abrupt decrease in temperature and dissolved oxygen. For both reservoirs in this study, the hypolimnion, when it occurred, generally was approximately 25 feet below the water surface. Although there was a slight variation about this depth on some dates of sampling, for the purpose of these calculations, it is assumed that the hypolimnion occurred at 25 feet for both the Guadalupe and the Almaden Reservoirs. Because the total stored volume in both the reservoirs decreased over the study period (Figure 4-2), with a substantial drop in elevation, the volume of water in the epilimnion and hypolimnion also changed with time, even though the depth of the hypolimnion from the surface remained constant.

The calculated volume of water stored in the hypolimnion and the epilimnion is shown in Figure 4-3. The hypolimnion volumes were calculated using the relationships in Figure 4-1, and the epilimnion volumes were estimated by difference from SCVWD data on the total stored water in the reservoirs. The time course of the sampling was not sufficient to determine when the stratification occurred and when it ended; however, based on other data available to us and from sampling conducted in the previous year, it is reasonable to assume that the stratification began in May and ended in September.

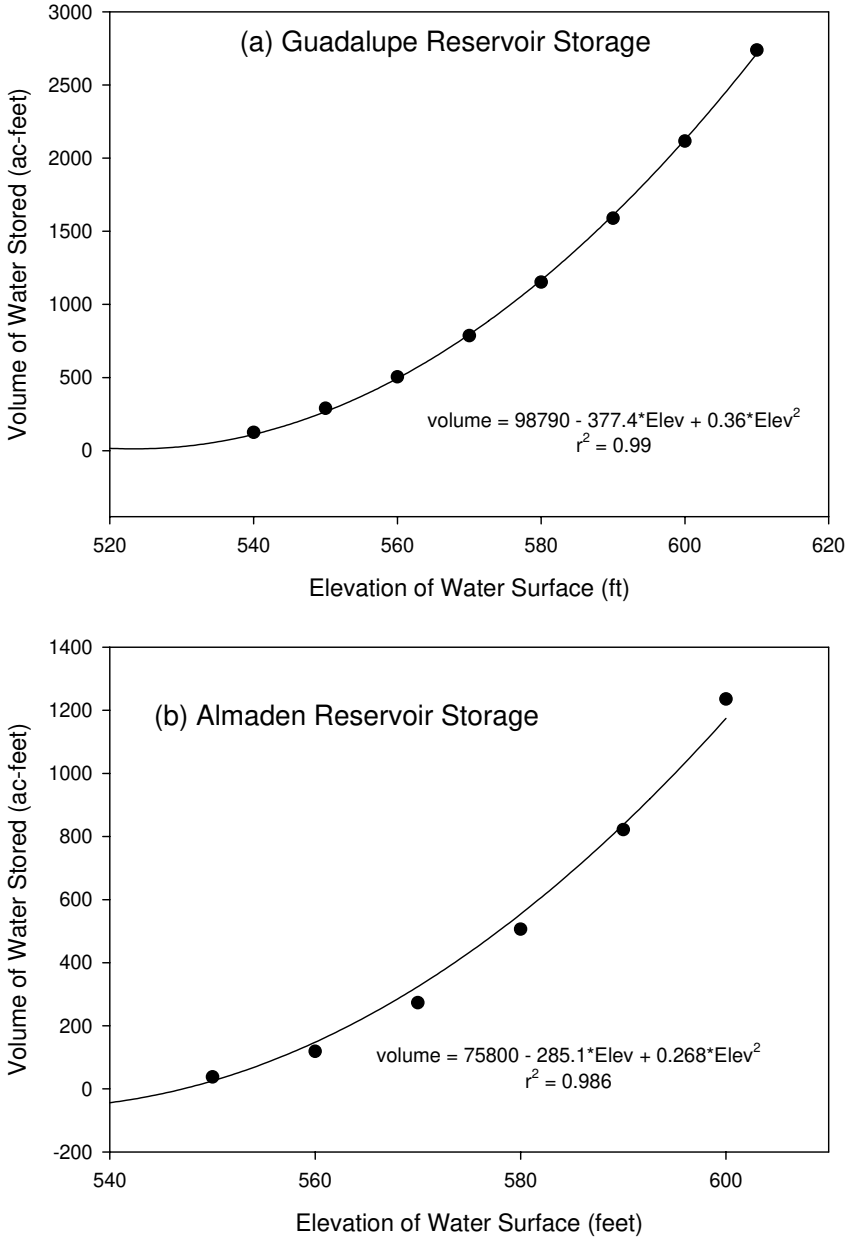


Figure 4-1. Volume of water stored as a function of surface elevation for (a) Guadalupe Reservoir, and (b) Almaden Reservoir. The stored water volumes were estimated from detailed bathymetric maps of the two reservoirs. The lines represent the best-fit non-linear regression for these data and were used to estimate the volume of water corresponding to various elevations of the hypolimnion.

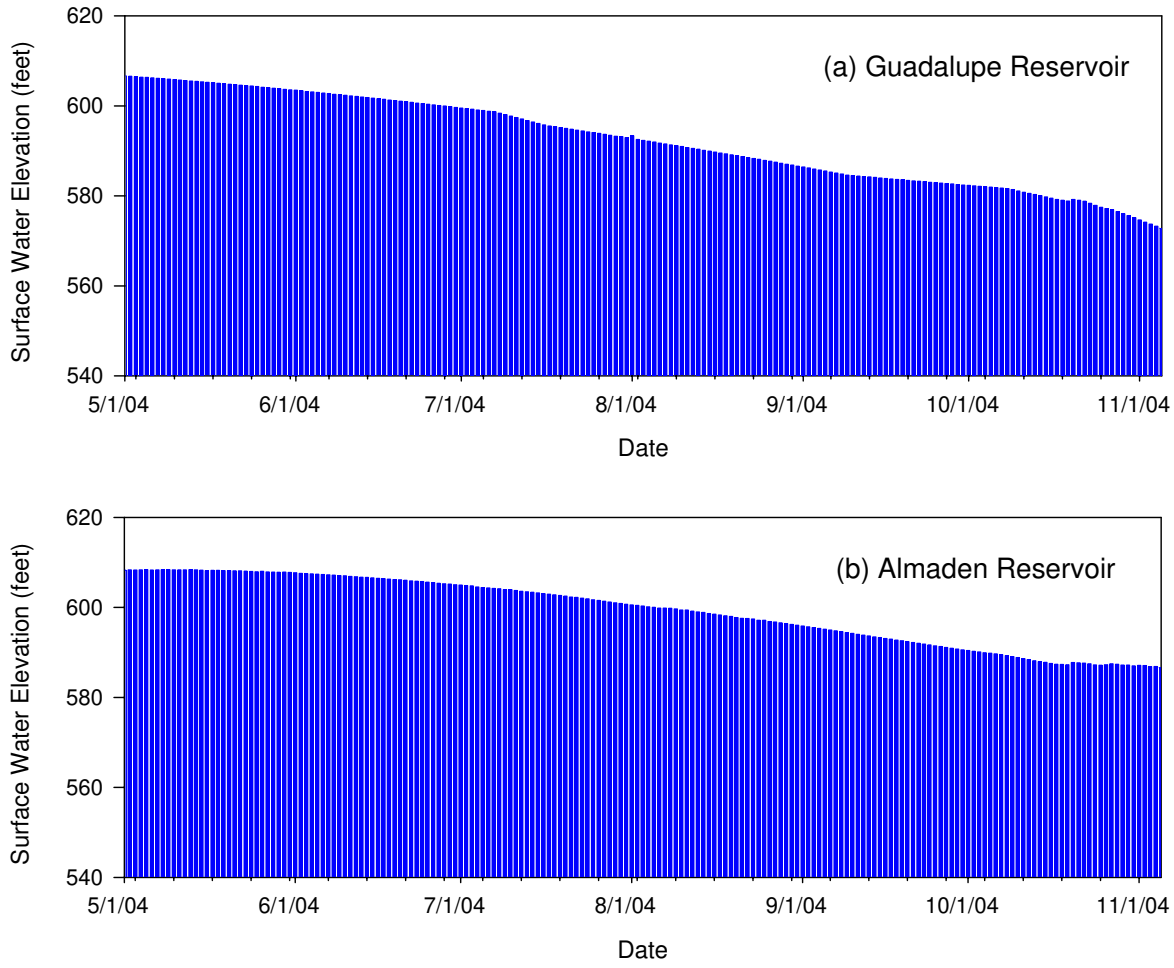


Figure 4-2. Surface water elevation of (a) Guadalupe Reservoir, and (b) Almaden Reservoir. The elevations were obtained from SCVWD's online data access system, http://alert.valleywater.org.

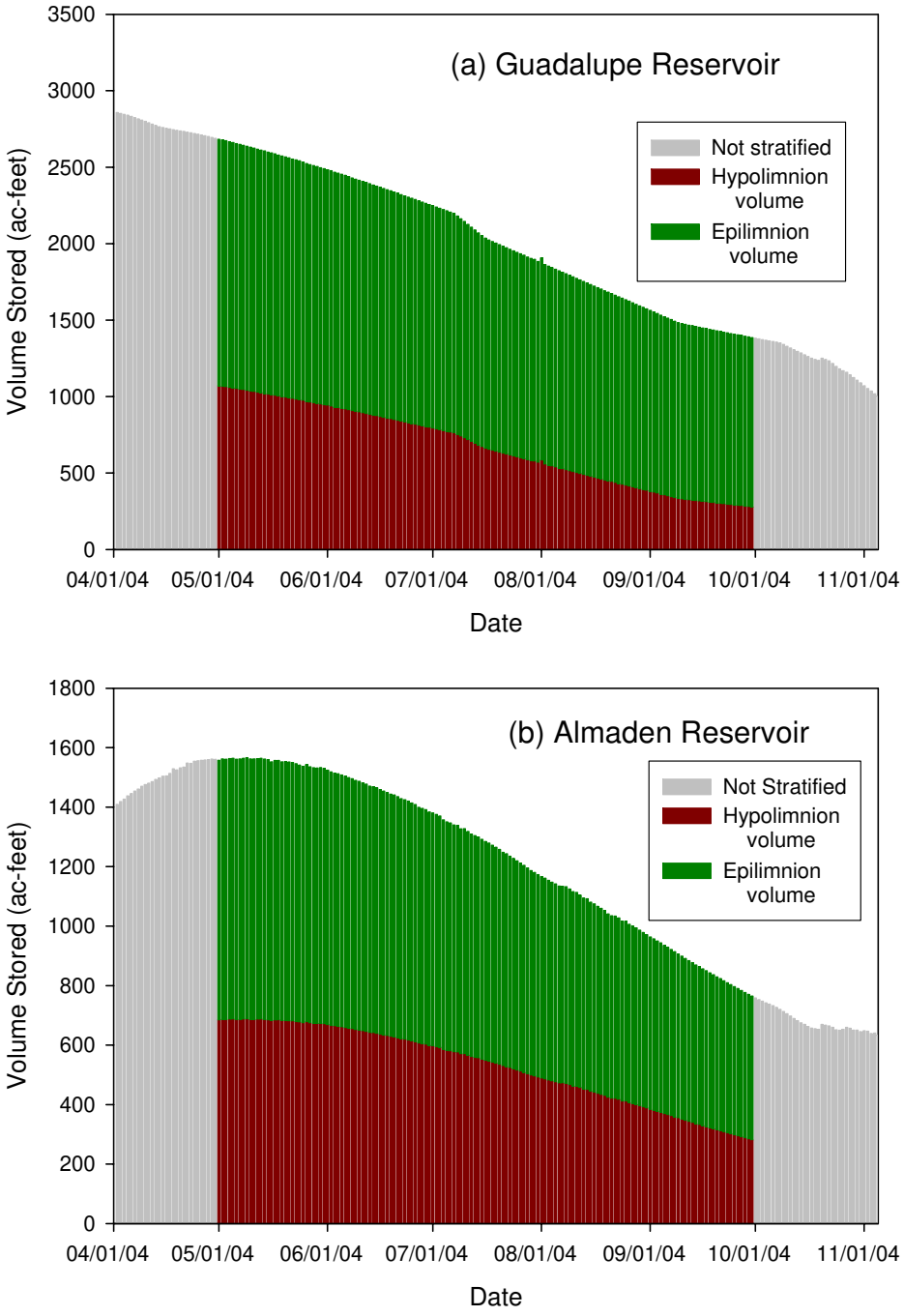


Figure 4-3. The calculated volume of water stored in the hypolimnion and the epilimnion of (a) Guadalupe Reservoir, and (b) Almaden Reservoir. The hypolimnion volumes was calculated using the relationships in Figure 4-1, and the epilimnion volumes were estimated by difference from SCVWD data on the total stored water in the reservoirs.

4.3 RESERVOIR OUTFLOWS

The volume of water flowing out of Guadalupe and Almaden Reservoirs is gauged continuously. For these calculations, an average daily flow rate was estimated from hourly data on flow obtained from the online ALERT system. In the dry season, these flows are roughly constant and in the vicinity of 5-6 cfs as shown in Figure 4-4. An exception occurs for Almaden reservoir for which a relatively large release, over 60 cfs daily average flow, was reported on one day in the 2004 dry season.

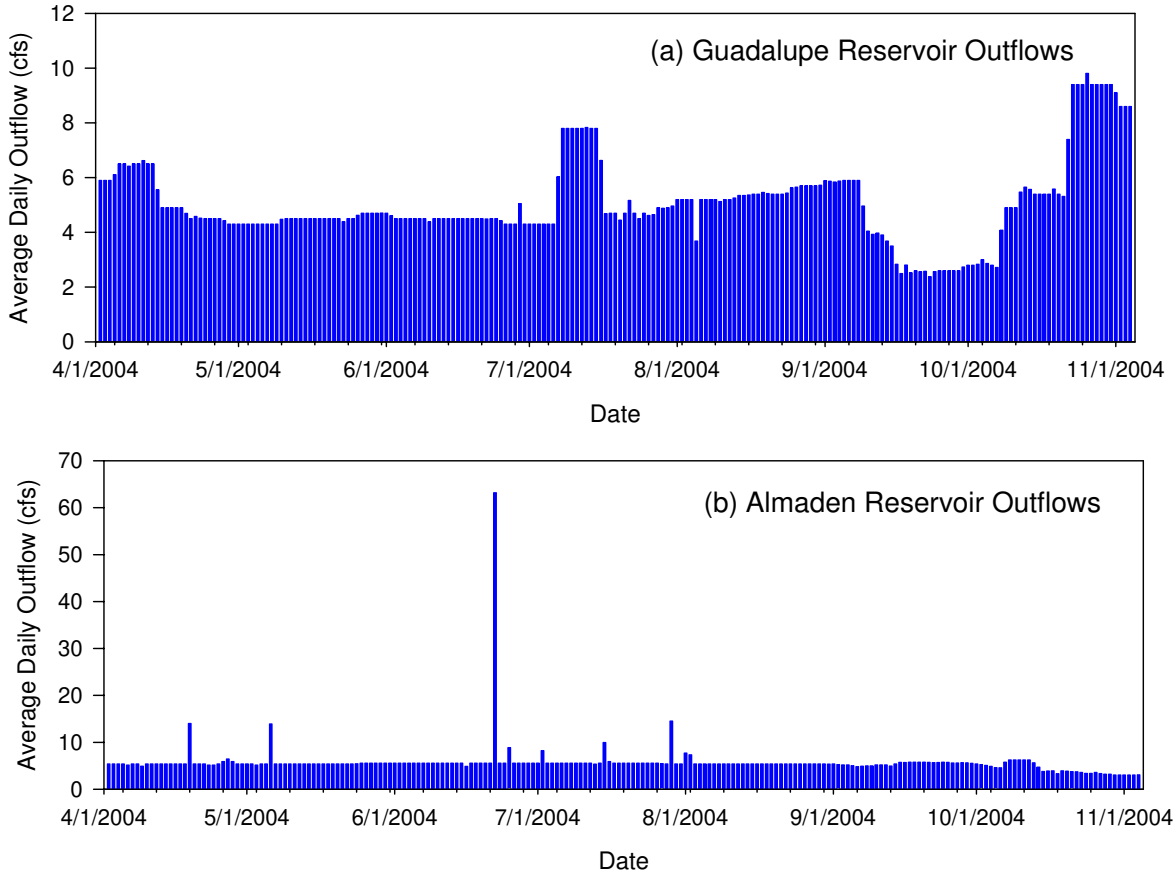


Figure 4-4. Average daily outflows from (a) Guadalupe Reservoir, and (b) Almaden Reservoir as reported in SCVWD's online data access system, http://alert.valleywater.org. Note the different y-axis scales on the two plots.

4.4 INTERNAL LOADS IN RESERVOIRS

The concentrations over the sampling period were multiplied by the volume of the hypolimnion or the epilimnion to determine the mass of total or methylmercury in either compartment. Because concentration data were obtained less frequently that depth or flow data, concentrations at dates without measurements were estimated by interpolation from the two nearest values with measurements.

The total mercury and the methylmercury loads and associated data for Guadalupe and Almaden Reservoirs are shown in Figures 4-5 through 4-8. Figure 4-5 shows the changing volume of the epilimnion and the hypolimnion in Guadalupe Reservoir, the total mercury concentrations, and the water column mass of mercury in the two compartments. The total mercury concentrations are relatively high ranging between 10 ng/l to more than 40 ng/l. There are high points for total mercury in June for the epilimnion and in late August for the hypolimnion. Over the course of the dry season, the total mercury mass in the epilimnion varies by a factor of four between 20 and 80 g (largely because of the high value in June), although the hypolimnion mass remains roughly constant at approximately 20 g. The trends for methylmercury in Guadalupe Reservoir are shown in Figure 4-6. In this instance there is a major difference between the epilimnion and the hypolimnion, with the latter showing a steep increase in concentration and total mass beginning in July. At the end of the dry season, the hypolimnion concentrations of methylmercury exceed 12 ng/l, whereas the methylmercury in the epilimnion remains below 0.5 ng/l. The methylmercury mass in the hypolimnion is 5.8 g, fourteen times higher than the epilimnion mass of 0.4 g. The mercury behavior in Almaden Reservoir exhibits some similarities with Guadalupe Reservoir although there are clear differences as well. Total mercury concentrations (Figure 4-7) are roughly constant in the epilimnion at about 4 ng/l, about 3-10 times lower than in Guadalupe Reservoir. Hypolimnion concentrations are higher than epilimnion concentrations (6-14 ng/l) but not as high as Guadalupe Reservoir. However, similar to Guadalupe Reservoir, there is an increase in hypolimnion concentrations later in the dry season. The mass of mercury in the hypolimnion is about three times higher than in the epilimnion (6 g vs. 2.1 g). Thus, Almaden Reservoir exhibits the same patterns as Guadalupe Reservoir, but the differences between the epilimnion and the hypolimnion are not as large. Almaden methylmercury patterns (Figure 4-8) are similar to those in Guadalupe. The hypolimnion concentrations increase dramatically in late summer, reaching a value of almost 6 ng/l in late August. The methylmercury mass in the hypolimnion is about 10 times larger than in the epilimnion (2.7 g vs. 0.26 g).

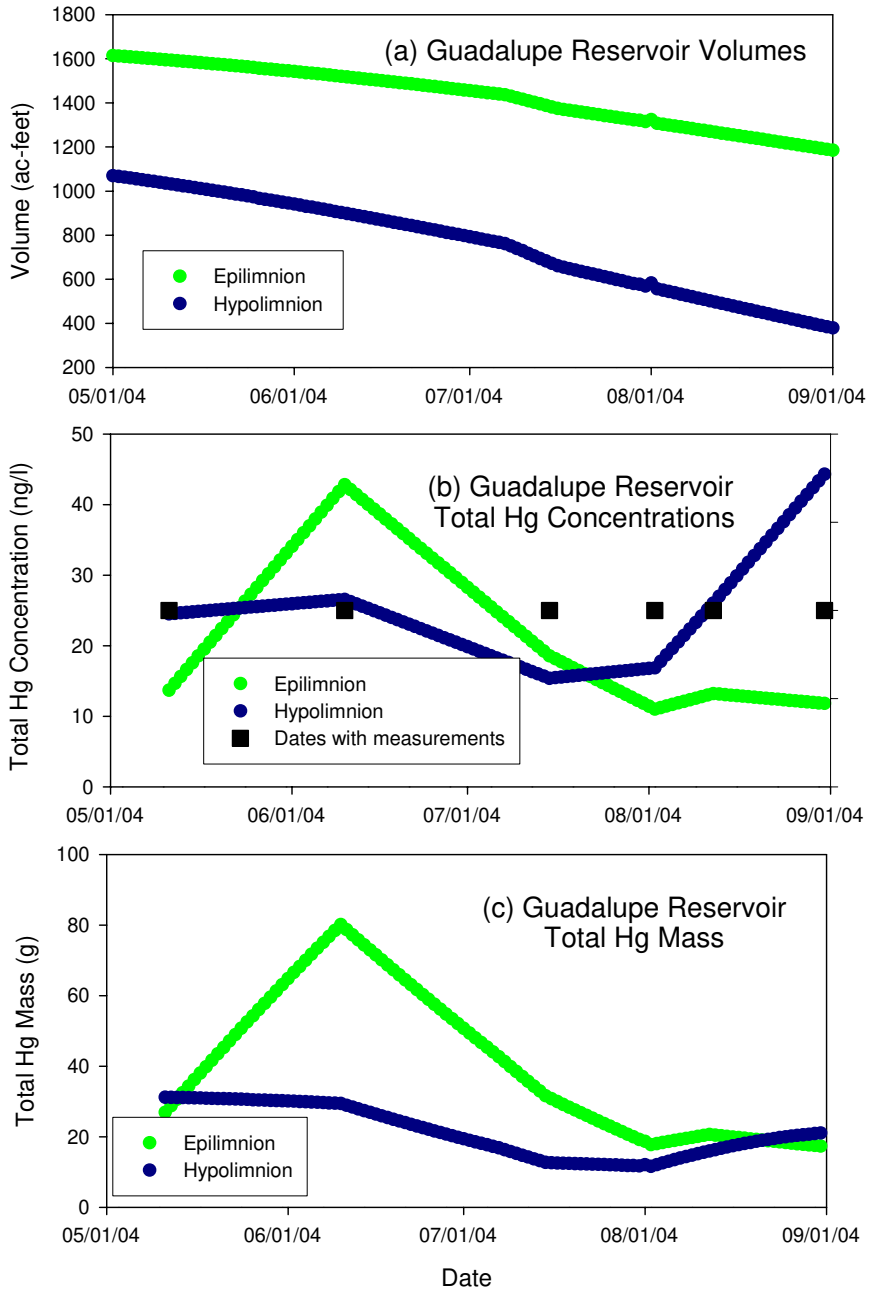


Figure 4-5. (a) Change in volume of the epilimnion and the hypolimnion, (b) the total mercury concentrations, and (c) the water column mass of mercury in the two compartments in Guadalupe Reservoir. Actual measurements of total mercury were made on the dates shown with black squares. Values at other dates are based on interpolations from measured values.

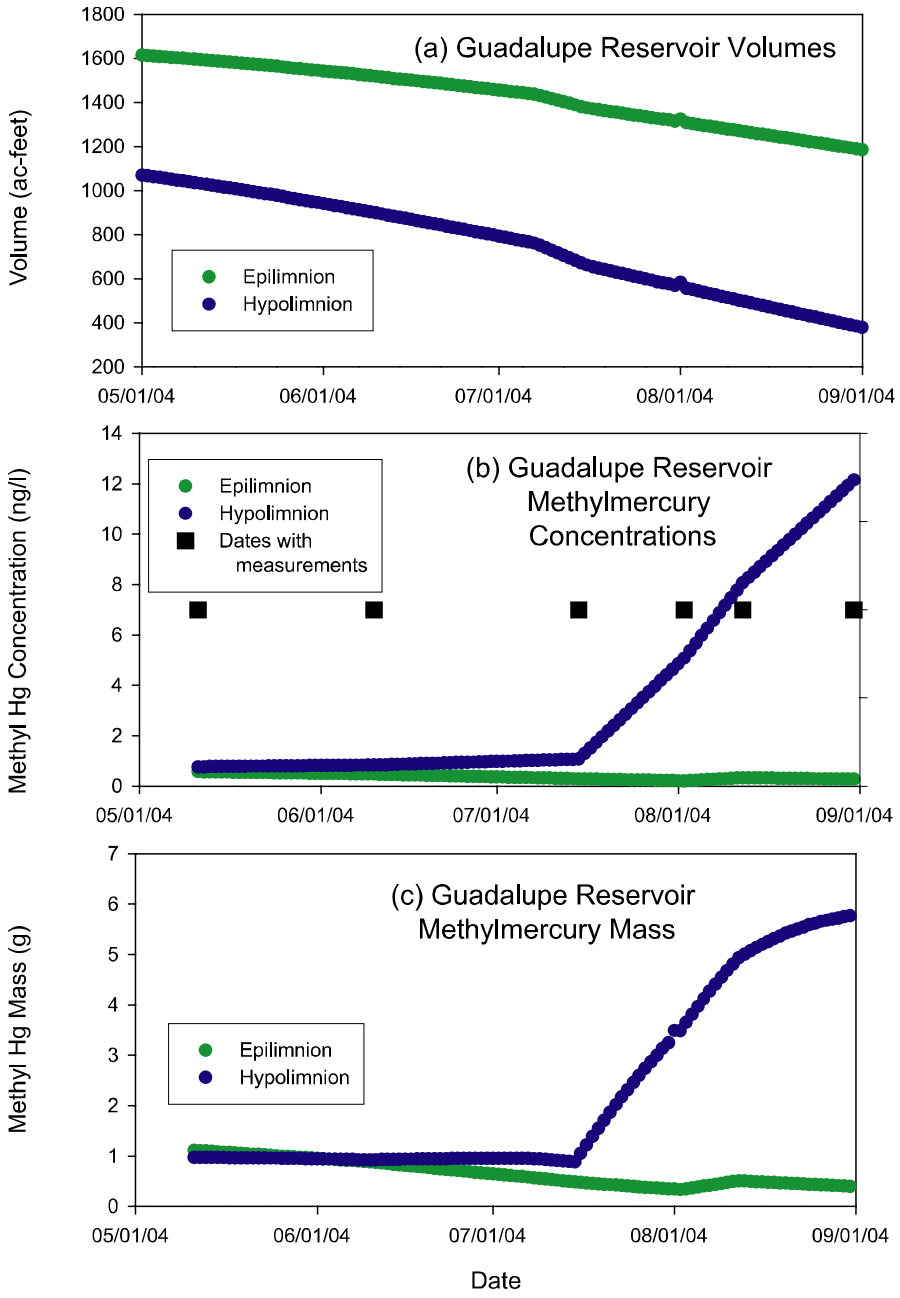


Figure 4-6. (a) Change in volume of the epilimnion and the hypolimnion, (b) the methylmercury concentrations, and (c) the water column mass of mercury in the two compartments in Guadalupe Reservoir. Actual measurements of methylmercury were made on the dates shown with black squares. Values at other dates are based on interpolations from measured values.

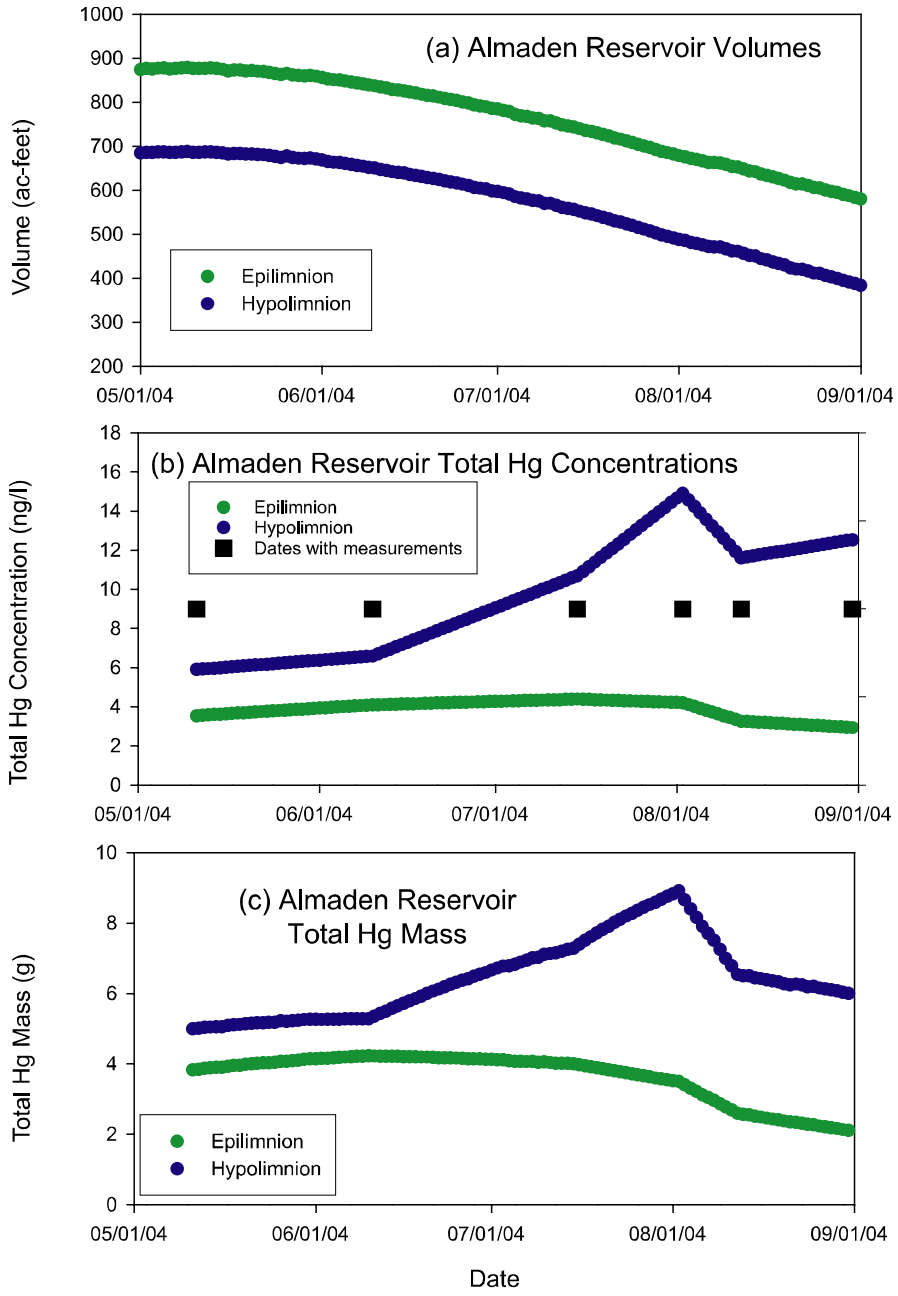


Figure 4-7. (a) Change in volume of the epilimnion and the hypolimnion, (b) the total mercury concentrations, and (c) the water column mass of mercury in the two compartments in Almaden Reservoir. Actual measurements of total mercury were made on the dates shown with black squares. Values at other dates are based on interpolations from measured values.

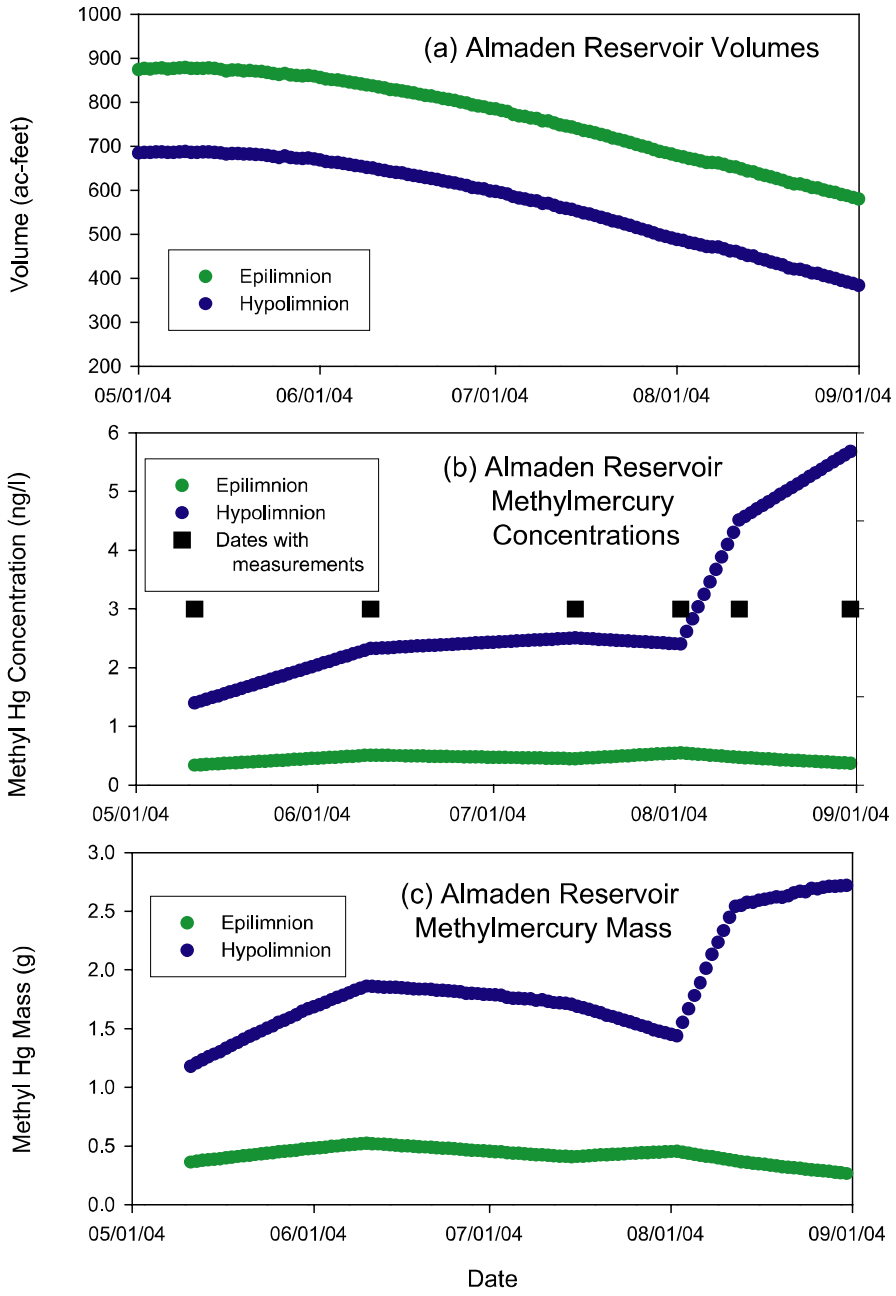


Figure 4-8. (a) Change in volume of the epilimnion and the hypolimnion, (b) the methylmercury concentrations, and (c) the water column mass of mercury in the two compartments in Almaden Reservoir. Actual measurements of methylmercury were made on the dates shown with black squares. Values at other dates are based on interpolations from measured values.

4.5 Exported Loads of Total Mercury and Methylmercury

The loads of mercury exported to Guadalupe Creek and Alamitos Creek were calculated as the product of mercury concentrations in the reservoir outflows, and the flow rate data routinely collected by SCVWD and reported on the ALERT system

(http://alert.valleywater.org). Daily average flow data was used (computed from 24-hourly values). Actual measured total and methylmercury concentration data were used when available; for dates without mercury data, values were interpolated from the nearest two dates of sampling.

The daily and cumulative exported loads for Guadalupe and Almaden Reservoirs are shown in Figure 4-9 and 4-10 respectively. Over May through August 2004, total mercury exported from Guadalupe Reservoir is about 37 g, or about 1.5 times the mercury remaining in the hypolimnion (Figure 4-5). Over the same period, methylmercury exports were about 5 g, roughly equal to the methylmercury remaining in the hypolimnion. For Almaden reservoir, total mercury exports were more than three times the mass remaining in the hypolimnion (21 g vs. 6 g). Methylmercury exports exhibited a similar pattern with exports being three times greater then final mass remaining in the hypolimnion (7.2 g vs. 2.7 g). Thus, Almaden Reservoir exports a significantly larger fraction of the total and methylmercury generated during the dry season than does Guadalupe Reservoir.

4.6 Relating Loads to Previous Calculations

In a previous report summarizing the results of the wet season sampling we reported on inflows and outflows of mercury from Guadalupe and Almaden Reservoirs. To develop a picture of the annual mercury loads, it is important to compare the wet season numbers with the calculations presented here.

Between October 2003 and May 2004, Guadalupe Reservoir received a total mercury load of 241.9 g and exported 149.2 g, thus being a net sink over the wet season (Table 8-5 in Tetra Tech, 2004a). In contrast, it exported a total mercury load of 37 g over the dry season, with minimal additional watershed inputs. Dry season watershed loads were not quantified, and although not zero, they are not expected to be a significant additional load. On net, the Guadalupe Reservoir was a net sink for total mercury. In contrast, Guadalupe Reservoir exported 1.4 g of methylmercury over the wet season, with 0.4 g of input, and exported a further 5 g during the dry season, with little additional external input. Thus, Guadalupe Reservoir is clearly a sink for total mercury and a net exporter of methylmercury.

Over the wet season Almaden Reservoir received a total mercury load of 217.8 g and exported 111.8 g, being a net sink in a manner similar to Guadalupe Reservoir (Table 8-5 in Tetra Tech, 2004a). It exported a total mercury load of 21 g over the dry season, with minimal additional watershed inputs, being a net sink for total mercury on an annual basis as well. In the wet season, Almaden Reservoir exported 0.8 g of methylmercury, with 0.6 g of input, and exported a further 7.2 g during the dry season, with little additional external input. Thus, on an annual basis, Almaden, like Guadalupe Reservoir, is a strong net exporter of methylmercury, and a sink for total mercury.

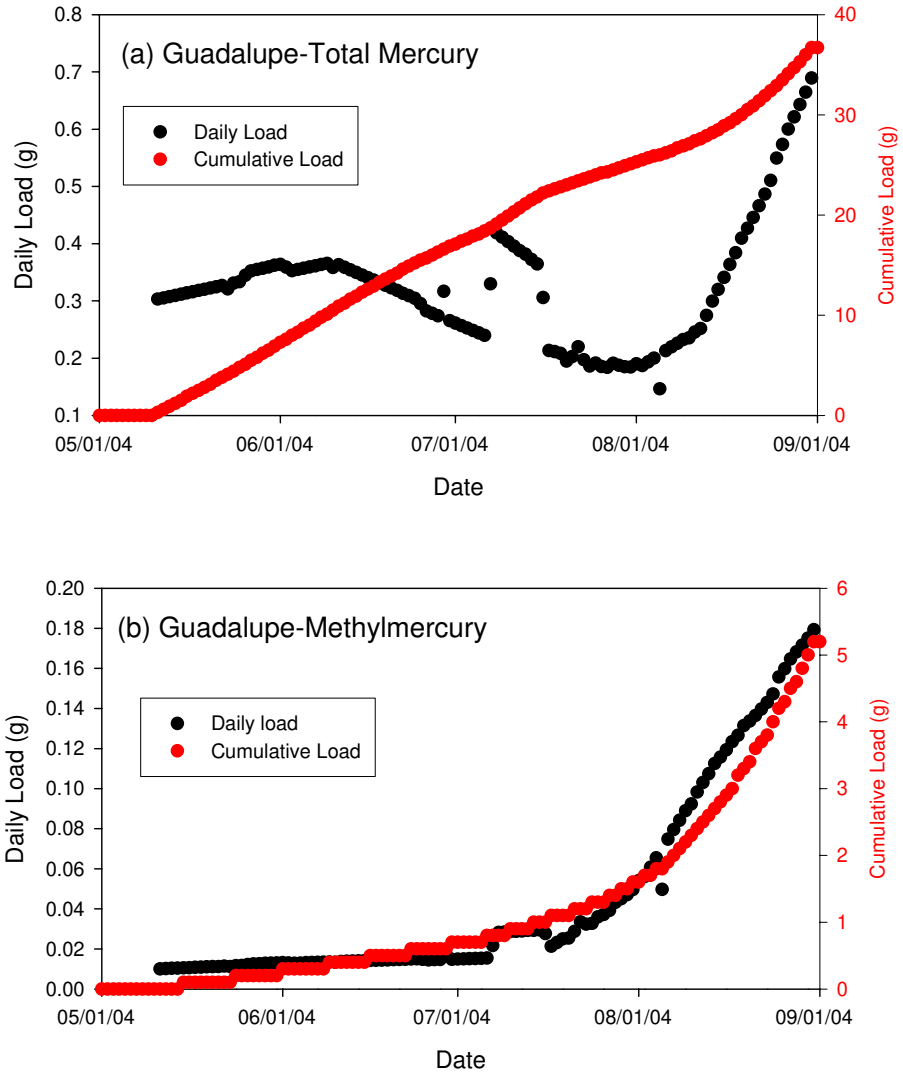


Figure 4-9. Daily and cumulative exported loads of (a) total mercury and (b) methylmercury from Guadalupe Reservoir. As done in the reservoir internal load calculations, actual measurements of total or methyl mercury were used in the load calculations where available, and values at other dates were based on interpolations from measured values.

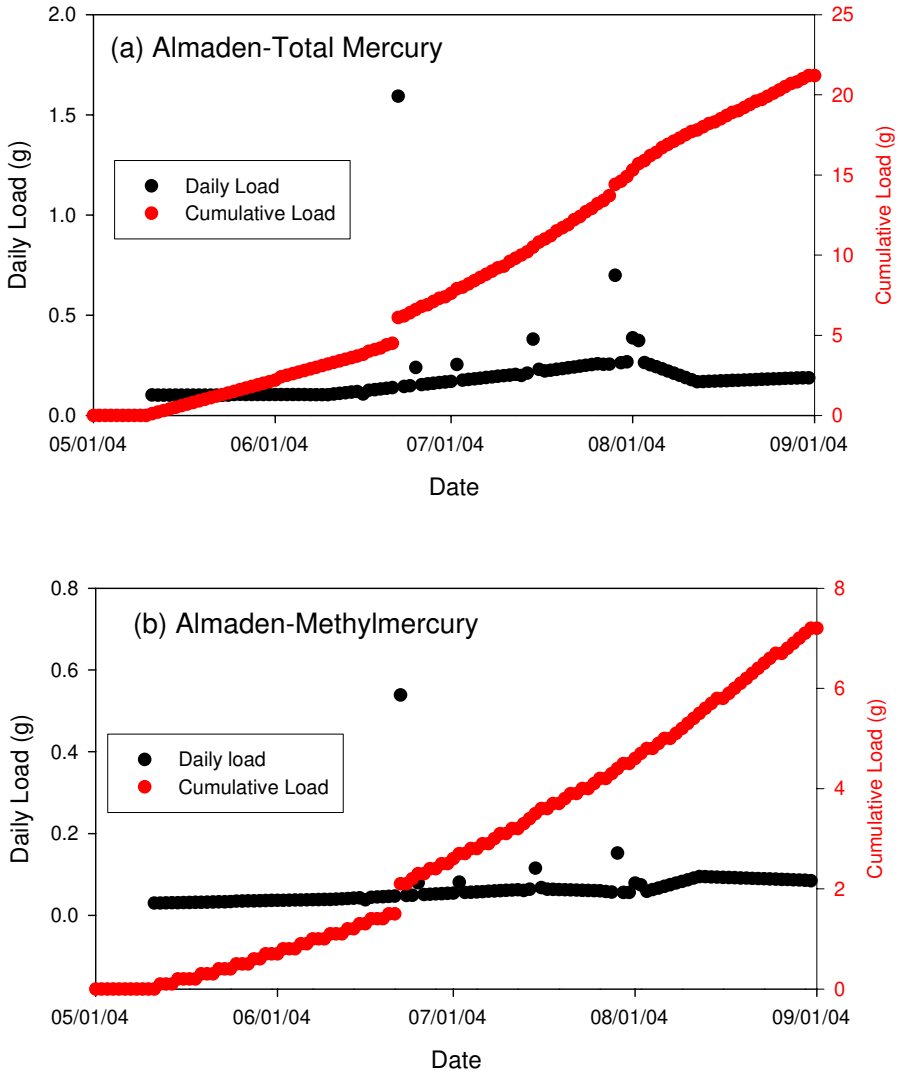


Figure 4-10. Daily and cumulative exported loads of (a) total mercury and (b) methylmercury from Almaden Reservoir. As done in the reservoir internal load calculations, actual measurements of total or methyl mercury were used in the load calculations where available, and values at other dates were based on interpolations from measured values.

4.7 Load Estimates and Hypotheses in Conceptual Model

The loads calculated in the preceding section can used to address two related hypotheses that were proposed in the Conceptual Model Report (Tetra Tech, 2004b). The hypotheses are presented in bold, followed by the conclusions.

A significant portion of the methylmercury produced in the reservoirs in the warm season is transported downstream to the creeks.

Based on the results presented above, this hypothesis is confirmed to be true. For both Guadalupe and Almaden Reservoirs, the downstream exports of methylmercury were equal to or greater than the methylmercury that is accumulated in the hypolimnion and the epilimnion during the dry season.

Methylation accumulated and/or produced in the epilimnetic zone of the reservoirs during the summer stratification period is significant and makes an important contribution of mercury to the food chain.

This hypothesis was found to be partially true. The epilimnion methylmercury accumulation is one-tenth to one-fourteenth of the hypolimnion mercury accumulation. This is the case even when a significant amount of the hypolimnion methylmercury is exported downstream. Hence, the epilimnion plays a small role in net methylmercury supply in the reservoirs; the dominant role is played by the hypolimnion.

5.0 BIOACCUMULATION IN FISH

The TMDL Workgroup members and the Technical Review Committee for the Draft Final Conceptual Model Report (Tetra Tech, 2004b) agree on the use of fish tissue mercury concentrations as the primary numeric target for the TMDL. Sampling Element 6 of the Data Collection Plan (Tetra Tech, 2004c) was developed to obtain new information on the concentration of mercury in fish tissue in the reservoirs and creeks throughout the watershed. Three hypotheses were developed as part of the effort to establish fish tissue mercury concentration as a numeric target:

1. Mercury concentrations in fish are elevated and represent a potential risk to their wildlife predators.
2. The measurement of mercury concentrations in an indicator species can be used to establish a baseline to compare changes in fish mercury concentrations over time and in response to mercury source reductions throughout the watershed.
3. A relationship can be developed between fish mercury concentrations and methylmercury concentrations measured in the water column.

These hypotheses formed the basis for the development of the objectives of the fish sampling plan described in the Draft Guadalupe Watershed Reservoir Fish Sampling Plan (USEPA, 2004):

1. Quantify the mercury concentrations in fish species that are important in recreational fishing, in order to establish if reductions are necessary for the protection of human health beneficial uses.

2. Where appropriate, provide a comparable data set to that being developed by the by the Surface Water Ambient Monitoring Program for the San Francisco Bay Region.

3. Provide baseline data for each reservoir that can be used to compare changes in fish mercury concentrations over time in response to mercury source reduction actions.

4. Quantify the mercury concentrations in fish species that represent potential prey items to the most sensitive set of wildlife species within the watershed in order to establish if reductions are necessary for the protection of wildlife beneficial uses.

5. Provide at least one TL2-TL3-TL4 relationship within the watershed to use across the watershed (if necessary) to translate fish tissue values to water column values, i.e. generate watershed specific bioaccumulation factors, in order to show attainment of water quality standards in water column values.

The results of the fish-sampling program that was conducted in the spring and summer of 2004 are described below. Emphasis is placed on describing how the results of the fish sampling and analyses meet the stated objectives.

As described in the Sampling and Laboratory Analysis section of this report (Section 2), two separate sets of fish samples were collected and analyzed for total mercury concentrations in the spring and summer of 2004. In a sampling program conducted by the USEPA, adult and age-1 largemouth bass (*Micropterus salmoides*) were collected in five reservoirs within the watershed. The results from the age-1 and adult largemouth bass sampling program are presented together, and the analyses conducted address the first three objectives. Santa Clara Valley Water District biologists collected samples of the California roach (*Lavina symmetricus*) at six creek and river locations in the watershed (SCVWD, 2004). These data are used to address Objective 4. The 2004 fish sampling program provides part of the information required to meet Objective 5. In a separate investigation (Kuwabara et al, 2004), phytoplankton and zooplankton samples were collected by the USGS in the same reservoirs in which the largemouth bass samples were collected. The summary of the results of the largemouth bass and California roach sampling and mercury analyses presented in this report is intended to provide a basis for the evaluation of trophic transfers and the development of watershed specific bioaccumulation factors.

5.1 LARGEMOUTH BASS DATA SET

5.1.1 ADULT LARGEMOUTH BASS SAMPLES

Total mercury concentrations were measured in muscle tissue samples from adult largemouth bass collected at five reservoirs in the watershed. The results are summarized in Table 5-1. The target sample size was 20 fish from each reservoir, and although fewer samples were collected at Guadalupe (n = 18) and Lexington (n=11) Reservoirs, these large numbers of samples at each reservoir provide an excellent summary of mercury concentrations in large predatory fish in the watershed. Both the average and range of mercury concentrations exhibit large differences between reservoirs. There is an order of magnitude difference in the average total mercury concentrations between Guadalupe Reservoir (6.1 mg/kg wet wt.) and Lexington Reservoir (0.6 mg/kg wet wt.). The coefficients of variation (CV) for the mercury measurements at each reservoir (0.16 – 0.40) are relatively low for environmental measurements. These low CV values indicate the narrow distribution

of mercury concentrations in the fish as well as the likelihood of detecting statistically significant differences in mercury concentrations between reservoirs (discussed below).

Table 5-1
Summary of Adult Largemouth Bass Mercury Data

		Total Mercury Concentrations (mg/kg wet)				Total Length (cm)			
Waterbody	Sample Size	Average	Min.	Max.	Coefficient of Variation	Average	Min.	Max.	Coefficient of Variation
Guadalupe Reservoir	18	6.1	3.1	13	0.40	41.8	30.7	53.2	0.18
Almaden Reservoir	20	4.3	2.2	7.4	0.30	43.9	33.8	51.2	0.11
Lake Almaden	20	2.3	1.1	3.8	0.34	41.8	31.2	53.2	0.16
Calero Reservoir	20	1.1	0.8	1.6	0.16	36.7	29.7	47.7	0.12
Lexington Reservoir	11	0.6	0.4	1.0	0.27	40.8	35.8	50.2	0.12

Although fork length was measured in the field, the data were converted to total length for comparison of mercury concentrations with fish from other data sets. The conversion of fork length to total length was based on the conversion factors presented in FishBase (Froese and Pauly, 2004): TL (cm) = 1.024 (FL, cm). The total length ranged from 30 cm to 53 cm. The average total length of largemouth bass was very similar at four of the five reservoirs. The fish caught at Calero Reservoir (average total length = 36.7 cm), however, were generally smaller than the fish caught at the other locations. Figure 5-1 shows the relationship between largemouth bass age and total length. Although the fish sizes are similar among reservoirs and the range of fish lengths is not large, the age of the fish in these samples can vary from four years in the smallest fish (30 cm) to as old as 10 years (53 cm).

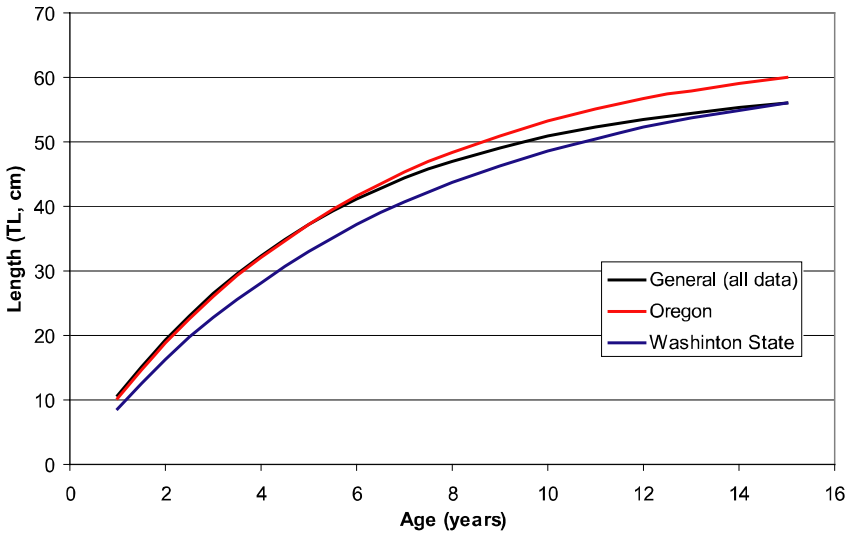


Figure 5-1 Relationship between largemouth bass age and total length (Froese and Pauly, 2004)

The relationship between total length (cm) and total mercury (mg/kg wet wt) in the adult largemouth bass samples is presented in Figure 5-2. There is an overall positive relationship between total length and total mercury concentration, although differences between the reservoirs affect the level of variability associated with the overall relationship. For example, distinct differences can be seen in the total length - total mercury concentration relationship between Guadalupe Reservoir and Lake Almaden (Figure 5-3). The magnitude and variability of total mercury concentrations in fish from Lake Almaden are less than fish from Guadalupe Reservoir over the entire size range of fish. Likewise the mercury concentrations in largemouth bass measured at Lexington Reservoir are less than the concentrations measured at all other reservoirs over the entire size range (Figure 5-2).

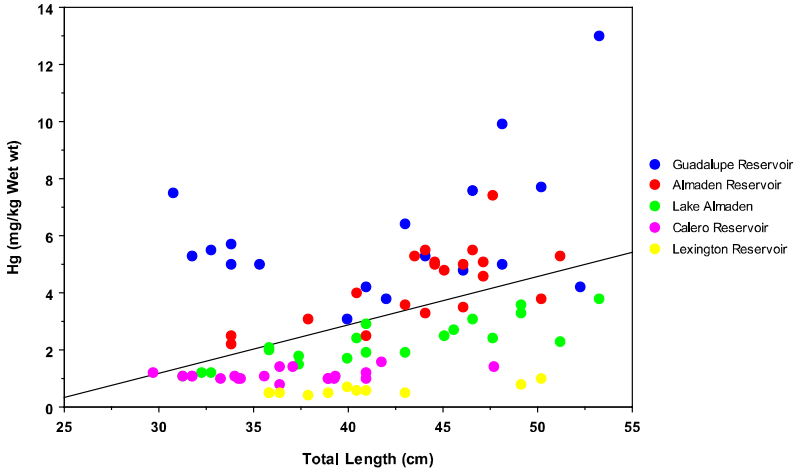


Figure 5-2. Relationship between total length and total mercury concentration in largemouth bass. Hg = -3.954 + 0.171; r^2 = 0.197

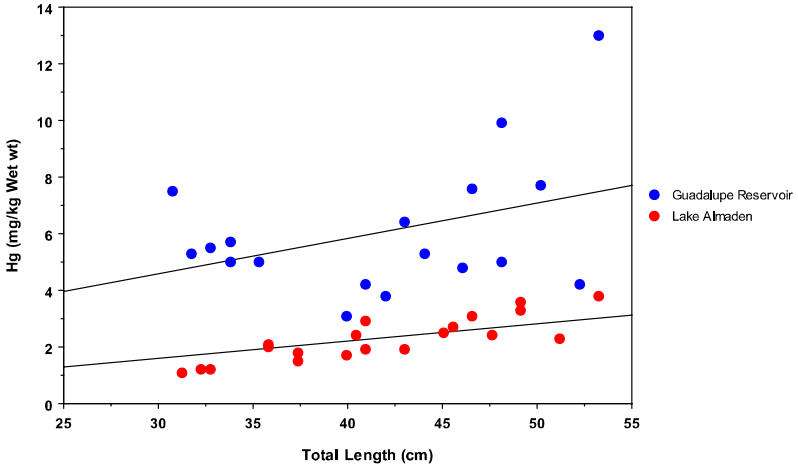


Figure 5-3. Relationship between total length and total mercury concentration in largemouth bass at Guadalupe Reservoir and Lake Alamaden. Guadalupe Reservoir (Hg = 0.872 + 0.124 TL; r^2 = 0.15); Lake Almaden (Hg = -0.226 + 0.061 TL: r^2 = 0.90)

The adult largemouth bass fish data collected by USEPA in the Guadalupe River Watershed in 2004 provide the necessary information to address the first two objectives described in the Draft Guadalupe Watershed Fish Sampling Plan (USEPA, 2004):

Objective 1. Quantify the mercury concentrations in fish species that are important in recreational fishing, in order to establish if reductions are necessary for the protection of human health beneficial uses.

Largemouth bass are an important recreational species and are used in the Sate of California's Surface Water Ambient Monitoring Program (SWAMP) as one of the species to monitor the mercury levels in edible fish tissue (SFBRWQCB, 2004). As shown in the range of total mercury concentrations measured in adult largemouth bass sampled in the Guadalupe River Watershed (Table 5-1), all 89 fish samples had edible tissue concentrations of mercury that exceed the State Office of Environmental Health Hazard Assessment (OEHHA) Screening Value (SV) and the U.S. EPA water quality criterion of 0.3 ppm (mg/kg wet wt.).

While all of the samples exceeded the State and Federal criterion value, there were distinct differences in the fish mercury concentrations between the five reservoirs sampled. The mercury concentrations in adult largemouth bass in the immediate vicinity of the mining district are some of the highest fish mercury levels found to date in California. The maximum mercury concentrations in adult largemouth bass at Guadalupe and Almaden Reservoirs and Lake Almaden ranged from 3.8 – 13 mg/kg wet wt. (Table 5-1). In comparison, the maximum mercury concentration in largemouth bass muscle tissue measured statewide in the Surface Water Ambient Monitoring Program between 1986 and 2001 was 3.5 mg/kg. The concentrations of mercury in largemouth bass from Lexington Reservoir, not directly affected by the mining district, are similar to mercury concentrations reported for adult largemouth bass at other locations throughout the San Francisco Bay region (see Objective 2).

Figure 5-4 presents the average and 95% confidence intervals for total mercury concentration in a 40 cm largemouth bass at the five reservoirs sampled. Regression equations were used to calculate the expected mercury concentrations corresponding to a specified (standardized) fish length (Bhattacharyya and Johnson, 1977; Tremblay et al, 1998) to account for the difference in the size of fish collected in the five reservoirs. The concentration of mercury in 40 cm largemouth bass exhibits a wide range (0.6 – 5.8 mg/kg) in the waterbodies sampled, and the measured concentrations appear to correlate well with the proximity to the mining district. Because the average total lengths for the adult largemouth bass samples at the five reservoirs were similar; the differences between the total mercury concentrations in the fish samples were tested using ANOVA and the SNK multiple comparison tests (Tremblay et al, 1998). The results of these tests indicate the existence of statistically significant differences in the mercury concentrations in adult largemouth bass between all pairs of reservoirs, except Calero and Lexington Reservoirs.

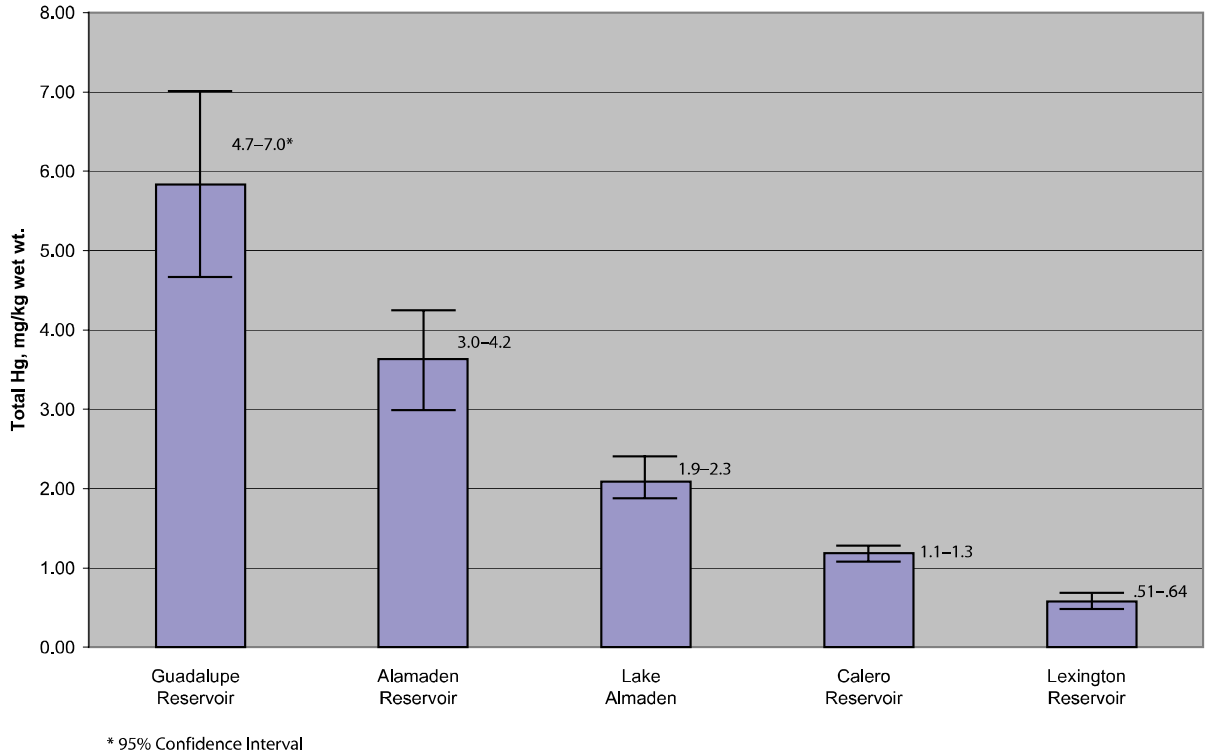


Figure 5-4. Mercury concentrations for standardized 40 cm largemouth bass.

Objective 2. Where appropriate, provide a comparable data set to that being developed by the Surface Water Ambient Monitoring Program (SWAMP) for the San Francisco Bay Region.

The Surface Water Ambient Monitoring Program (SWAMP) Report for the San Francisco Bay Region prepared by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB, 2004) describes surveys of reservoirs in which edible fish were collected and their tissues analyzed to determine the concentrations of contaminants, including mercury, which may affect human health. Mercury concentrations were measured in largemouth bass in nine reservoirs in Marin, Contra Costa, Alameda, and Santa Clara Counties. These data are summarized in Table 5-2.

Although there are differences between the SWAMP data set and the adult largemouth bass data set collected from the Guadalupe River Watershed, the data sets are comparable. Fewer samples were collected at each location in the SWAMP data set, but they are composite samples. The total number of fish represented in each reservoir varies from six to twenty-nine fish. The total length of the largemouth bass collected in the SWAMP data set (22 – 50 cm) is similar to the sizes represented in the Guadalupe River Watershed data set (30 – 53 cm).

Table 5-2.
Summary of Adult Largemouth Bass Data from Surface Water Ambient Monitoring Program

		Total Mercury Concentration (mg/kg wet wt.)			Total Length (cm)		
Waterbody	**Sample Size[1]**	**Average**	**Min.**	**Max.**	**Average**	**Min.**	**Max.**
Soulajule Reservoir	9	0.9	0.4	1.9	36.3	21.6	49.5
Nicasio Reservoir	3	0.6	0.2	1.3	37.5	30.3	45.4
Bon Tempe Reservoir	2	0.7	0.5	0.9	42.3	36.5	48.0
Lake Chabot	3	0.6	0.5	0.6	36.4	34.7	38.8
Del Valle Reservoir	3	0.8	0.8	0.9	37.1	33.2	42.8
Anderson Reservoir	3	1.1	0.7	1.5	37.0	29.8	45.0
Stevens Creek Reservoir	3	1.4	1.4	1.6	44.8	41.0	47.6
Lafayette Reservoir	3	0.4	0.3	0.7	41.2	34.5	49.6
Shadow Cliffs Reservoir	2	0.7	0.7	0.7	43.5	38.2	48.7

[1] Composite samples of three to five individual fish

Table 5-3 provides a comparison of the total mercury concentrations measured in largemouth bass from both the Guadalupe River Watershed and other reservoirs in the San Francisco Bay area represented in the SWAMP data set. All total mercury concentrations presented in Table 5-3 are standardized to a 40 cm largemouth bass. The standardized values were calculated, as described above (Bhattacharyya and Johnson, 1977; Tremblay et al, 1998), using regression equations to account for the different size fish collected in the reservoirs. Since only two samples were collected at Bon Tempe and Shadow Cliffs Reservoirs, the required regression equations could not be generated, and these reservoirs were excluded from the analysis.

Table 5-3.
Waterbodies Listed By Decreasing Mercury Concentrations (mg/kg wet wt) Standardized For A 40 Cm Largemouth Bass

Highlighted reservoirs are from the SWAMP database.

Waterbody	**Total Hg (mg/kg)**
Guadalupe Reservoir	5.8
Almaden Reservoir	3.6
Lake Almaden	2.1
Stevens Creek Reservoir	1.4
Anderson Reservoir	1.3
Calero Reservoir	1.2
Soulajule Reservoir	1.1
Del Valle Reservoir	0.9
Nicasio Reservoir	0.8
Lexington Reservoir	0.6
Lake Chabot	0.6
Lafayette Reservoir	0.4

The results presented in Table 5-3 show that the mercury concentrations in the waterbodies in the vicinity of the mining district area of the Guadalupe Watershed are elevated above the concentrations in the other reservoirs sampled in the San Francisco

Bay area. The concentrations of mercury measured in largemouth bass in Calero and Lexington Reservoirs are more similar to the concentrations measured at other reservoirs in the region.

5.1.2 AGE-1 LARGEMOUTH BASS SAMPLES

Total mercury concentrations were measured in whole-body samples of age-1 largemouth bass collected at the same five reservoirs in the Guadalupe Watershed. The results are summarized in Table 5-4. Twenty fish of similar size were obtained from each reservoir, and the variability of the measurements, as indicated by the low coefficients of variation, was low within each reservoir. While the variability of the mercury measurements was low within reservoirs, large differences were observed in the fish mercury concentrations between the reservoirs. The total mercury concentrations measured ranged from 0.06 mg/kg wet wt at Lexington Reservoir to 1.53 mg/kg wet wt at Almaden Reservoir. All forty samples from Almaden and Guadalupe Reservoirs had mercury tissue concentrations that exceed the U.S. EPA water quality criterion of 0.3 ppm (mg/kg wet wt.).

Table 5-4.
Summary Of Age-1 Largemouth Bass Mercury Data

		Total Mercury Concentrations (mg/kg wet)				Total Length (cm)			
Waterbody	Sample Size	Average	Min.	Max.	Coefficient of Variation	Average	Min.	Max.	Coefficient of Variation
Guadalupe Reservoir	20	0.83	0.64	1.11	0.17	9.0	7.7	9.7	0.07
Almaden Reservoir	20	0.96	0.58	1.53	0.29	6.9	5.6	8.2	0.10
Lake Almaden	20	0.39	0.21	0.53	0.22	9.3	8.0	10.2	0.08
Calero Reservoir	20	0.21	0.10	0.58	0.53	7.4	5.5	10.2	0.22
Lexington Reservoir	20	0.09	0.06	0.14	0.22	8.9	7.1	10.2	0.10

Objective 3. Provide baseline data for each reservoir that can be used to compare changes in fish mercury concentrations over time in response to mercury source reduction actions.

In their review of the Data Collection Plan (Tetra Tech, 2004c) the technical Review Committee (TRC) highly recommended the sampling and analysis of young prey fish to provide a sensitive indicator of the abundance of methylmercury in aquatic food webs. Dr. James Wiener, one of the TRC members, pointed out that the annual sampling and analysis of small prey fish can be expected to reveal annual changes in the abundance of methylmercury, whereas the analysis of older fish could be expected to indicate only multi-year trends in the abundance of methylmercury. In addition, the analysis of age-1 fish would provide useful "baseline" information against which future concentrations can be compared. It was also pointed out that data on mercury on young fish should yield a more defensible relation between methylmercury concentrations in fish and water, than would data on older fish. Mercury concentrations are much less variable in young fish than in old fish, and

small fish typically vary less in trophic position than do larger individuals of the same species. Exposure conditions are also more uncertain in old fish than in young fish.

The results of the 2004 sampling of fish tissue in the reservoirs support the recommendations of the TRC. The variability of mercury measurements in fish tissue in adult largemouth bass within each reservoir was considered low with coefficients of variation (CV) between 0.16 to 0.40 (Table 5-1). The coefficients of variation for the age-1 largemouth bass mercury concentrations were, with the exception of the CV value at Calero Reservoir, lower (between 0.17 and 0.29, Table 5-4). Figure 5-5 presents the average and 95% confidence intervals for total mercury concentrations in an 8 cm largemouth bass at the five reservoirs sampled.

The lower sample variability in mercury concentrations in the age-1 largemouth bass samples and the more rapid response expected in age-1 fish to changes in methylmercury concentrations in the reservoirs make the age-1 fish a good indicator of methylmercury concentrations in aquatic food webs in the Guadalupe Watershed. The results of the sampling program conducted by the US EPA clearly indicate that the age-1 largemouth bass will make a good biosentinel to detect changes in response to interventions that reduce methylmercury concentrations in the aquatic food web.

5.2 CALIFORNIA ROACH DATA SET

Santa Clara Valley Water District biologists collected samples of the California roach (*Lavinia symmetricus*) from six locations in creeks and the Guadalupe River (SCVWD, 2004). Nine locations, representing a wide range of expected aqueous mercury concentrations, were initially selected for sampling (Figure 5- 6), but only a few or no roach were present at some of the sampling locations. Whole fish samples, with the gastrointestinal tract removed to prevent contamination with mercury from ingested sediment, were collected to quantify the mercury concentrations in fish species that represent potential prey items to wildlife species (Objective 4). It was also anticipated that these samples could be used to contribute to our understanding of the linkage between mercury concentrations in the water column and fish tissue (Objective 5).

Objective 4. Quantify the mercury concentrations in fish species that represent potential prey items to the most sensitive set of wildlife species within the watershed in order to establish if reductions are necessary for the protection of wildlife beneficial uses.

The results of the California roach sampling effort and the mercury analyses are presented in Table 5-5. All samples were similar in size, between 40 to 55 mm fork length, and based on the examination of scales, age-1 or younger (SCVWD, 2004). The measured mercury concentrations ranged from an average value of 0.03 mg/kg wet wt in Los Gatos Creek (Site 9, Figure 5-6), which is fed by Lexington Reservoir to an average value of 0.39 mg/kg wet wt on Guadalupe Creek (Site 4, Figure 5-6), which is fed by Guadalupe Reservoir. At the Guadalupe Creek sampling site at

Meridian Avenue, the mercury concentrations in the tissue of all 20 California roach were greater than the U.S. EPA water quality criterion of 0.3 mg/kg wt wet.

ANOVA and SNK multiple range tests were used to examine the statistical significance of observed differences in the average mercury concentrations of these whole-body fish samples between locations (Tremblay et al, 1998). The average mercury concentrations at the Guadalupe River at Foxworthy Avenue and Alamitos Creek at Greystone Avenue (Sites 1 and 6, Figure 5-6) were equal (0.15 mg/kg wet wt), but the differences between the measured mercury concentrations at the other four sites were each significantly different from one another. The range of values at each sampling location and the magnitude of the differences between these locations is shown in the box plots in Figure 5-7. These plots show the 10th, 25th, 50th (median), 75th and 90th percentiles of the fish mercury concentrations. Values above the 90th and below the 10th percentile are plotted as points.

These results clearly demonstrate the ability to quantify the mercury concentrations in fish that are potential prey items to wildlife in the watershed. California roach are omnivores and filamentous algae is the primary staple in their diet, but they can also feed on small insects and crustaceans (Moyle 2002). The California roach are intermediate between Trophic Level 2 (TL2) or TL3 species. The low variability in the mercury concentrations measured at each location, indicated by the small values of the coefficients of variation, suggest that the California roach, like the age-1 largemouth bass, will also make a good biosentinels to detect changes in response to interventions that reduce methylmercury concentrations in the aquatic food web.

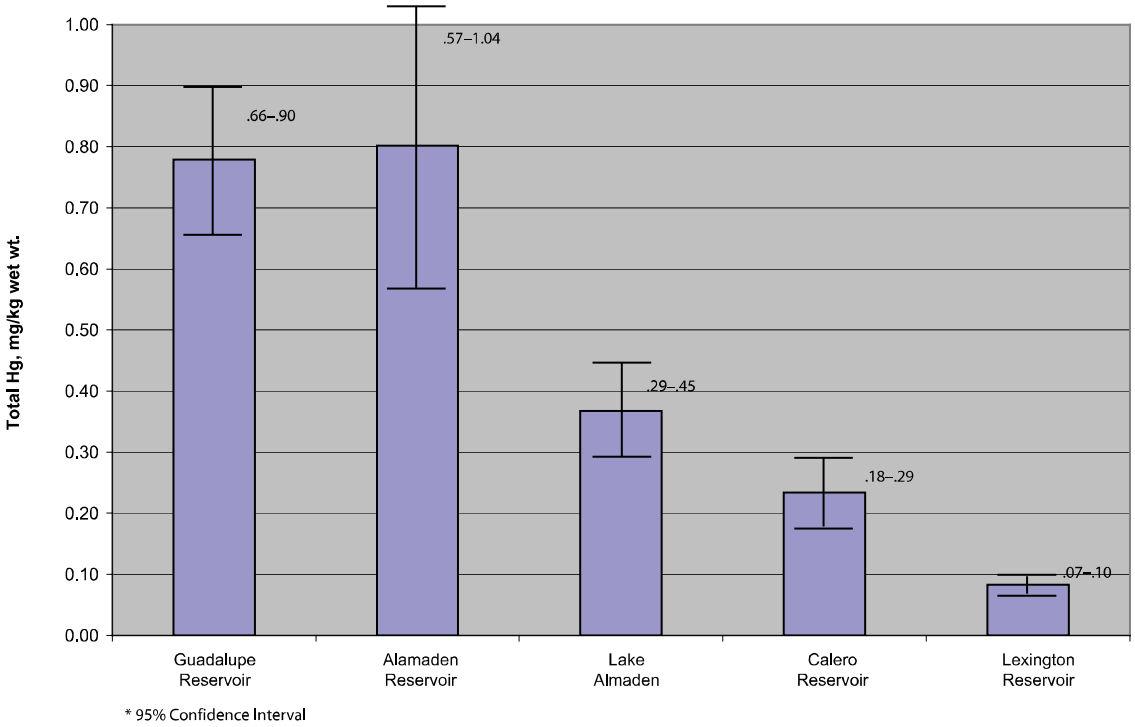


Figure 5-5. Mercury concentrations for standardized 8 cm largemouth bass.

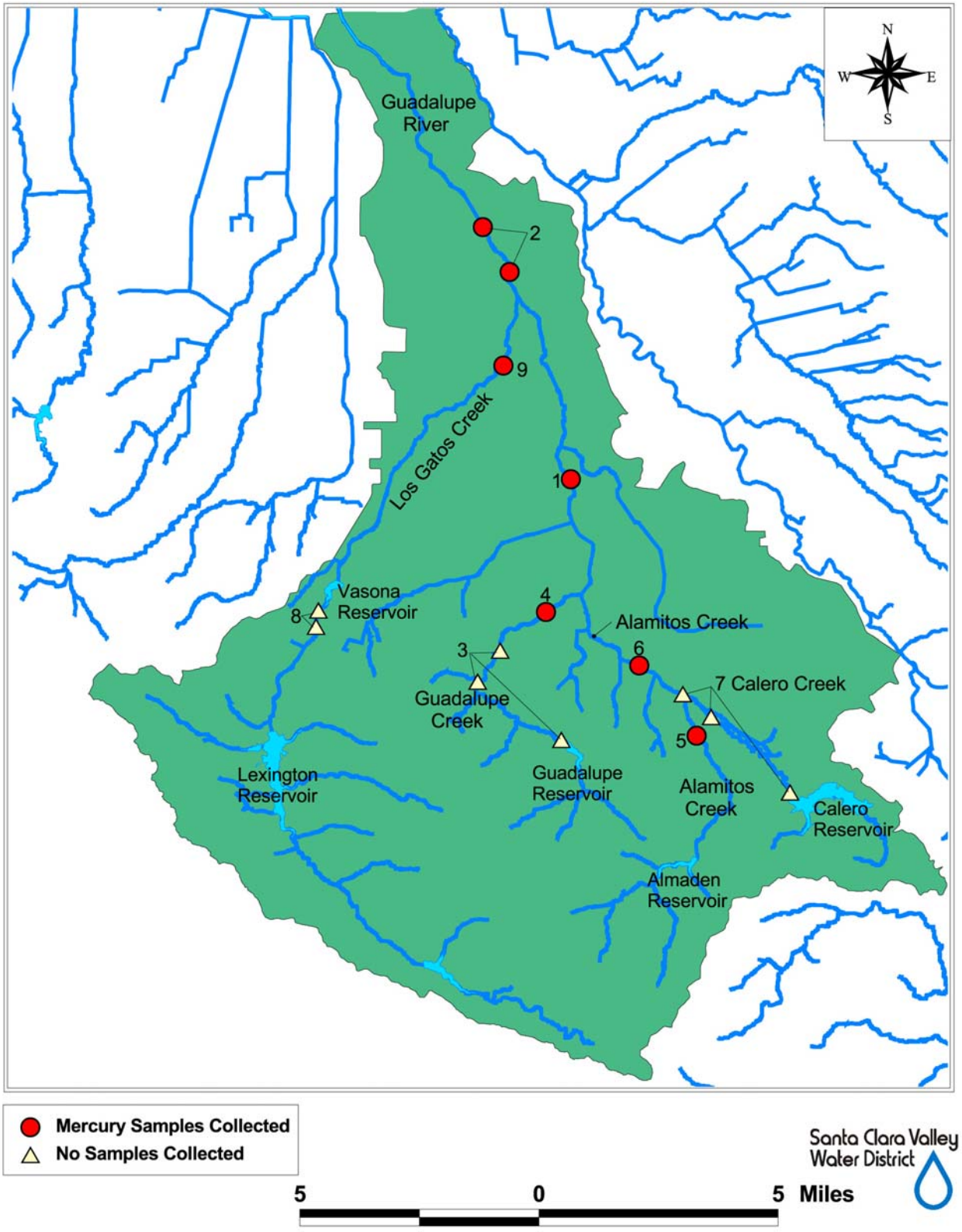


Figure 5-6. Stream sampling sites in the Guadalupe Watershed (SCVWD, 2004).

Table 5-5.
Summary of California Roach Mercury Data

Waterbody and Location	Sample Size	Total Mercury Concentrations (mg/kg wet)			
		Average	Min.	Max.	Coefficient of Variation
Guadalupe R., at Foxworthy Ave.	9	0.15	0.12	0.19	0.17
Guadalupe R., at Coleman Ave.	25	0.08	0.04	0.12	0.32
Guadalupe Creek, at Meridian Ave.	20	0.39	0.31	0.48	0.11
Alamitos Creek, at Harry Road	20	0.28	0.20	0.41	0.21
Alamitos Creek, at Greystone Lane	20	0.15	0.10	0.26	0.26
Los Gatos Creek, at Linclon Ave.	20	0.03	0.02	0.04	0.24

5.3 SUMMARY AND SYNTHESIS OF BIOACCUMULATION DATA

The results of both the largemouth bass and California roach sampling and analysis programs have demonstrated the existence of significant differences in fish tissue mercury concentrations between sampling locations. These differences are related to the proximity to historical mercury mining activities. The next step in the synthesis of the data collected in Part 2 of the Guadalupe Watershed Data Collection Program is to examine the relationship between the water and sediment mercury measurements and the fish tissue mercury measurements. The initial objective is to quantify these relationships. The goal for the Guadalupe River Watershed Mercury TMDL is to satisfy the final objective described in the Draft Guadalupe Watershed Fish Sampling Plan:

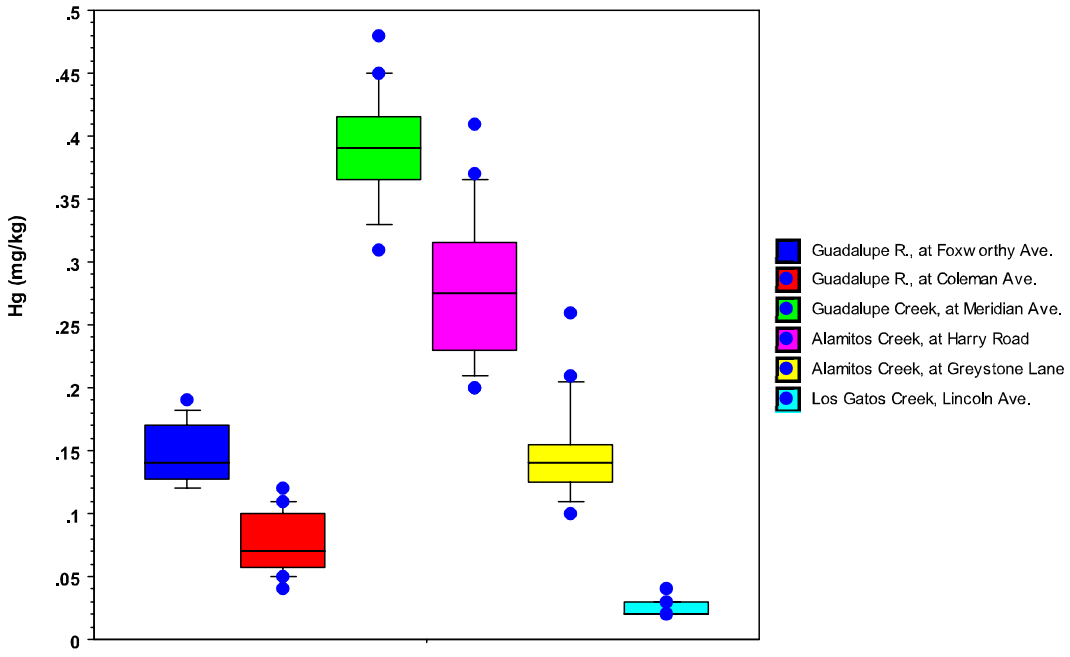


Figure 5-7. Mercury concentration in California roach collected at six locations in the Guadalupe River Watershed.

Objective 5. Provide at least one TL2-TL3-TL4 relationship within the watershed to use across the watershed (if necessary) to translate fish tissue values to water column values, i.e. generate watershed specific bioaccumulation factors, in order to show attainment of water quality standards in water column values.

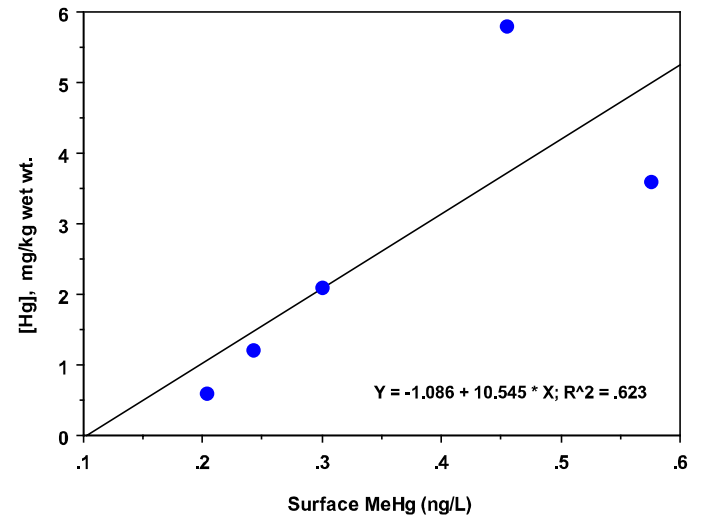
Table 5-6 presents paired measurements of total mercury concentration in adult largemouth bass at the five locations sampled by the U.S. EPA in 2004 and unfiltered aqueous methylmercury concentrations in the surface and hypolimnion of the reservoirs. The fish tissue concentrations are the average total mercury measurements for a 40 cm adult largemouth bass. These data, as has been shown in Section 5.1, provide an excellent representation of the mercury concentrations in large piscivorous fish in the reservoirs of the Guadalupe Watershed. The water concentrations in Table 5-6 are averages of measurements at Almaden and Guadalupe Reservoirs on one date in July 2003 and six dates between May 11 and August 31, 2004. These measurements were taken at both the surface and at the reservoir outlet (referred to in the table as the hypolimnetic samples since water is released from the bottom of the reservoirs below the thermocline). The July 2003 samples were collected for the Synoptic Survey (Tetra Tech, 2003b), while 2004 samples were collected for Part 2 of the Data Collection Plan (see Section 3 of this report). The mercury concentrations at Almaden and Guadalupe Reservoirs are well characterized. A single value is used for for the surface-water methylmercury concentration at Lake Almaden. This value is the average of two samples collected at the outlet in April 2004 as part of the Wet Weather Sampling under Part 1 of the Data Collection Plan (Tetra Tech, 2004a). There is no measurement for the hypolimnion at Lake Almaden. The surface-water and hypolimnion values for Calero and Lexington Reservoirs are from samples collected on one date in July 2003.

Table 5-6.
Paired Mercury Measurements In Adult Largemouth Bass And Reservoir Water Samples.

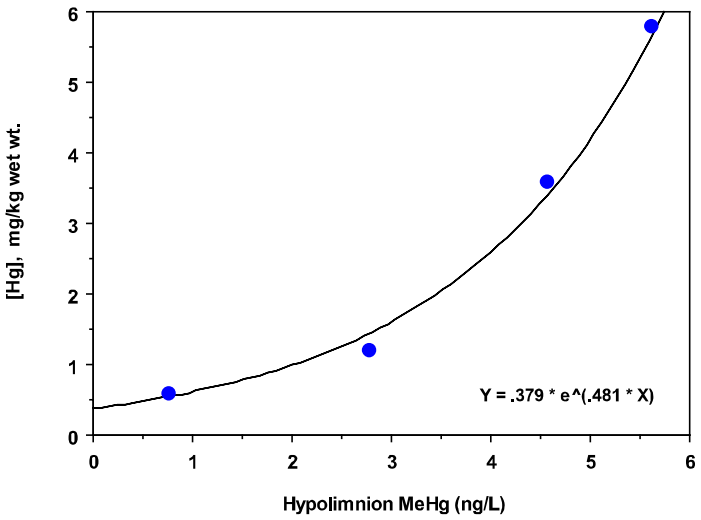
		MeHg, ng/l unfiltered		Log(BAF, L kg-1)	
Waterbody	**Average Fish Tissue Total Hg *mg/kg wet***	**Surface**	**Hypolimnion**	**Surface**	**Hypolimnion**
Guadalupe Reservoir	5.80	0.46	5.61	7.1	6.0
Almaden Reservoir	3.60	0.58	4.57	6.8	5.9
Lake Almaden	2.10	0.30	-	6.8	-
Calero Reservoir	1.20	0.24	2.77	6.7	5.6
Lexington Reservoir	0.60	0.20	0.76	6.5	5.9

The relationship between the mercury concentration in the adult largemouth bass and the water samples is shown in Figure 5-8. Fish mercury concentrations are positively correlated with the methylmercury concentrations measured in both the surface water and the hypolimnion. The exponential relationship between the methylmercury concentration in the hypolimnion and the mercury concentration in the adult largemouth bass may be related to the fact that the average methylmercury concentrations in Guadalupe and Almaden Reservoirs used in the regression analysis underestimate methylmercury production in the systems. The average values were

calculated using measurements collected throughout the period of reservoir stratification, but methymercury production rates increase with time (and oxygen depletion) during the summer stratification period. Conversely, mercury methylation may not increase significantly or as rapidly during the summer stratification period in an uncontaminated waterbody like Lexington Reservoir.



(A)



(B)

Figure 5-8. Relationship between mercury concentrations in adult largemouth bass and methylmercury concentrations in surface (A) and hypolimnetic (B) waters samples.

The log transformed values of the bioaccumulation factors (BAFs) are also shown in Table 5-6. The BAF is the ratio of the tissue concentration to the water column concentration of mercury in units of L kg^{-1}:

$$BAF = CT/CW * 10^6$$

where:

CT = MeHg concentration in the fish tissue, mg/kg
CW= MeHg concentration in the water, ng/L

The calculated values of the BAF are within the expected range for large piscivorous fish. The concentration of methylmercury in the adult largemouth bass is approximately 0.5 – 10 million times the methylmercury levels in the water column (surface and hypolimnion samples). However, the BAFs calculated with the hypolimnetic methylmercury concentrations with a range of 400,000 – 1,000,000 may be a better indicator for the adult largemouth base since these fish are long-lived, and the hypolimnetic values are more representative of the maximum methylmercury production levels of the reservoirs.

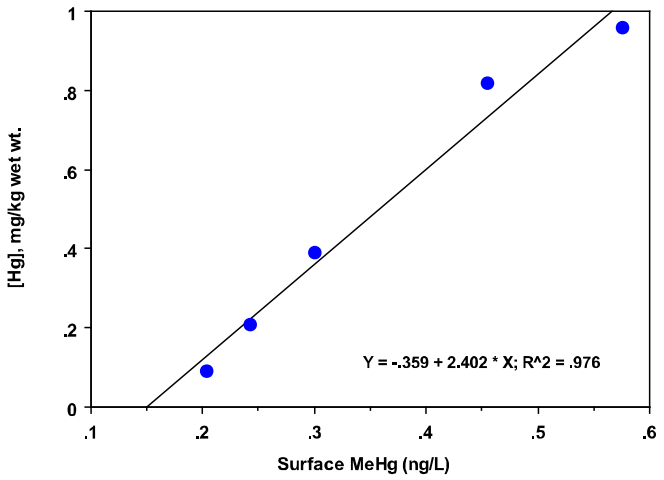
Table 5-7 presents paired measurements of total mercury in the age-1 largemouth bass and unfiltered methylmercury in the surface and hypolimnion of the reservoirs in the Guadalupe Watershed. The fish tissue concentrations are the values calculated for an 8 cm age-1 largemouth bass and previously presented in Figure 5-5. The water concentrations in Table 5-7 are the same concentrations that were presented in Table 5-6. As shown in Figure 5-9, the paired mercury concentrations are positively correlated. The fit of the data is especially good for the relationship between the surface water methylmercury concentration and the concentration of mercury in the age-1 largemouth bass ($r^2 = 0.98$).

Table 5-7.
Paired Mercury Measurements In Age-1 Largemouth Bass And Reservoir Water Samples.

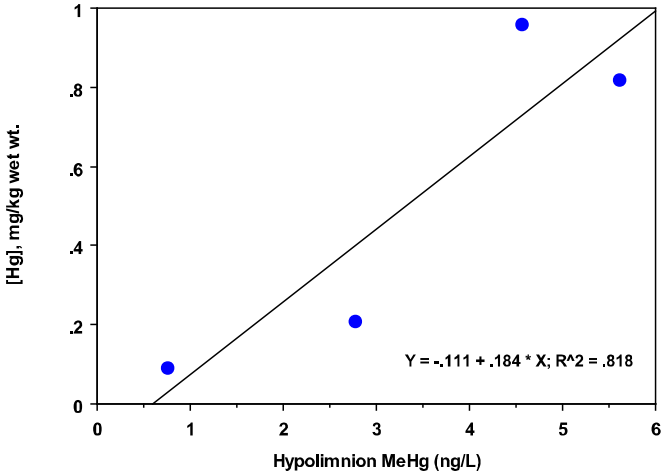
		MeHg, ng/l unfiltered		Log(BAF, L kg-1)	
Waterbody	**Average Fish Tissue Total Hg *mg/kg wet***	**Surface**	**Hypolimnion**	**Surface**	**Hypolimnion**
Guadalupe Reservoir	0.82	0.46	5.61	6.3	5.2
Almaden Reservoir	0.96	0.58	4.57	6.2	5.3
Lake Almaden	0.39	0.30	-	6.1	-
Calero Reservoir	0.21	0.24	2.77	5.9	4.9
Lexington Reservoir	0.09	0.20	0.76	5.6	5.1

Since the concentrations of methylmercury in the water is the same in both Tables 5-6 and 5-7, the calculated BAFs for the age-1 largemouth bass samples presented in Table 5-6 are related to the BAFs for the adult largemouth bass by the ratio of the tissue concentrations in these two age classes. These ratios are also referred to as Trophic Transfer Coefficients. The values of these coefficients for these two levels of the food web in the five reservoirs in the Guadalupe Watershed are presented in Table 5-8. The relationship between mercury concentrations in the tissue of age-1

largemouth bass and adult largemouth bass is notably consistent in all five reservoirs (Figure 5-10).



(A)



(B)

Figure 5-9. Relationship between mercury concentrations in age-1 largemouth bass and methylmercury concentrations in surface (A) and hypolimnetic (B) waters samples.

Table 5-8.
Trophic Transfer Coefficients, 1-Year Old to Adult Largemouth Bass

Waterbody	Trophic Transfer Coefficient
Guadalupe Reservoir	7.1
Almaden Reservoir	3.8
Lake Almaden	5.4
Calero Reservoir	5.7
Lexington Reservoir	6.7

A summary of mercury concentrations measured in fish, surface water and sediments at the six locations sampled by the SCVWD in 2004 is presented in Table 5-9. The fish tissue concentrations are the average total mercury concentrations in California roach that are also presented in Table 5-5. The water samples were collected at five sites near the fish sampling locations in July 2003 as part of the Synoptic Survey (Tetra Tech, 2003b). In addition to the unfiltered results that are shown in the table, dissolved mercury and methylmercury were also collected. These water samples were collected on one date, except at Site 5 where replicate water samples were collected and averaged. Most water samples were collected at or close to the fish sampling locations, except for Site 1 where the July 2003 water sample was collected upstream above the confluence with Ross Creek, instead of downstream.

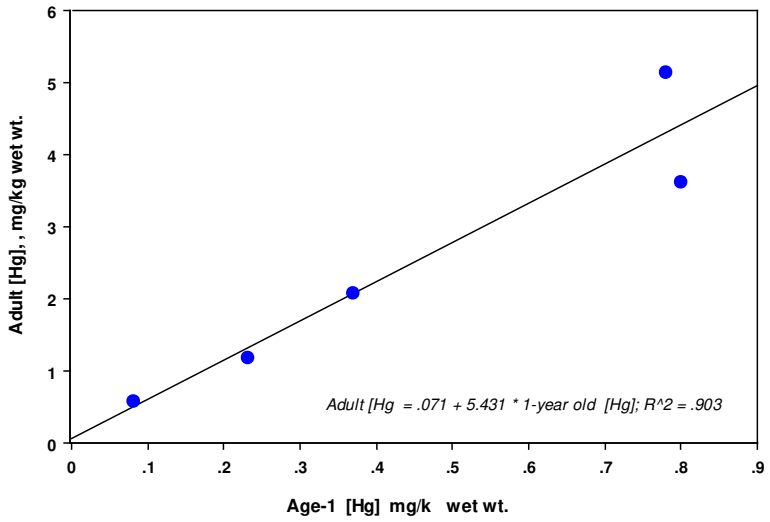


Figure 5-10. Relationship between mercury concentrations in the tissue of age-1 and adult largemouth bass.

The sediment data presented in Table 5-9 were collected near three of the sites (4, 5, 6, and 9) as part of the Synoptic Survey in July 2003. These bottom sediment samples were collected at the same locations and times as the water samples described above. Replicate samples were collected at Site 5 and averaged. Sediment samples were also collected at two locations near Sites 4 and 6 in March 2004 as part of the Wet Weather Survey (Part 1 of the Data Collection Plan). For these two sites, the July 2003 and March 2004 data were averaged. Four sediment samples were collected below Site 2 at the new USGS gauge at Highway 101 at four locations across the river bottom in March 2004 as part of the Wet Weather Survey. This location is several miles downstream of Site 2.

There is not a strong relationship between total mercury concentration in the surface water and the mercury in the tissue of the California roach (Figure 5-11 A). However, a strong positive relationship is exhibited between the unfiltered methylmercury concentrations in the streams and Guadalupe River and the measurements of mercury in the fish tissue (Figure 5-11 B). The strength of this relationship is reflected in both the r^2 value (0.95) and the small range of values for

the BAF (Table 5-9), which were calculated using the values for the unfiltered methylmercury concentrations. The concentration of methylmercury in the California roach is approximately 300,000 to 600,000 times the methylmercury levels in the water column.

Table 5-9.
Summary of Stream Sampling Mercury Data

Site	Waterbody	Fish Total Hg mg/kg wet	Total Hg, ng/l unfiltered	Me Hg, ng/l unfiltered	Log(BAF) ($L\ kg^{-1}$)	Sed Total Hg (ng/g)	Sed MeHg (ng/g)
1	Guadalupe R., Foxworthy	0.15	105	0.323	5.66	-	-
2	Guadalupe R., Coleman Ave.	0.08	-	-	-	971	1.03
4	Guadalupe Crk, Meridian Ave.	0.39	38.9	0.990	5.60	20,369	1.29
5	Alamitos Crk, Harry Road	0.28	503.2	0.886	5.50	26,586	7.29
6	Alamitos Crk, Greystone	0.15	25.88	0.306	5.68	18,081	0.91
9	Los Gatos Crk, Lincoln	0.03	3.2	0.037	5.83	42	0.04

The relationship between mercury concentrations in California roach and total mercury and methylmercury concentrations in sediment samples is shown in Figure 5-12. As measured by the value of the coefficient of determination ($r^2 = 0.69$) the relationship between total mercury and fish mercury concentrations appears to be important. However, the relationship is not statistically significant ($p = 0.08$), and the strength of the relationship may be driven by the fact that the few data points represent either low values or very high values (18, 000 – 26,000 ng/g or 18 – 26 mg/kg).

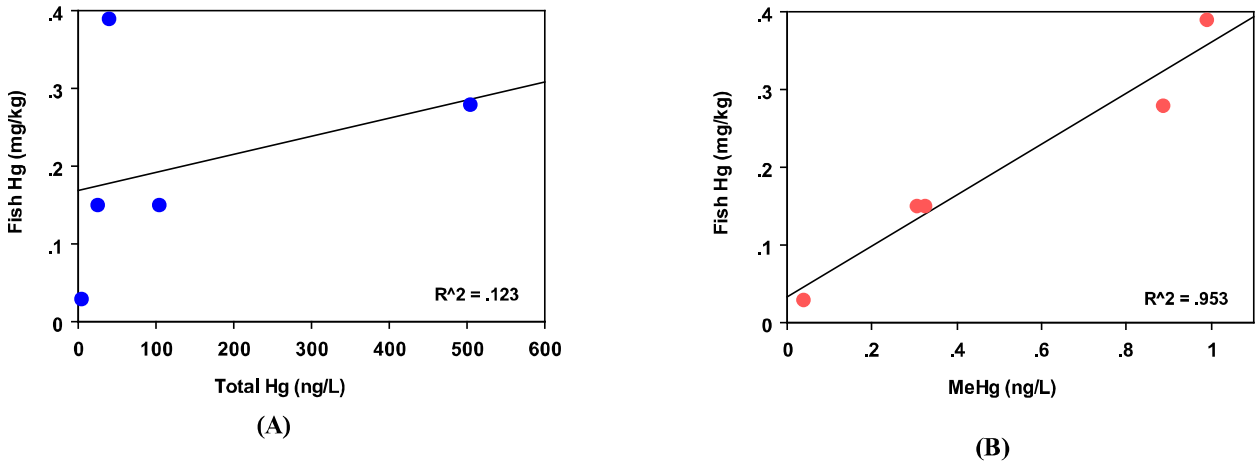


Figure 5-11. Relationship between mercury concentrations in California Roach and unfiltered total mercury (A) and methylmercury (B) concentrations in water samples.

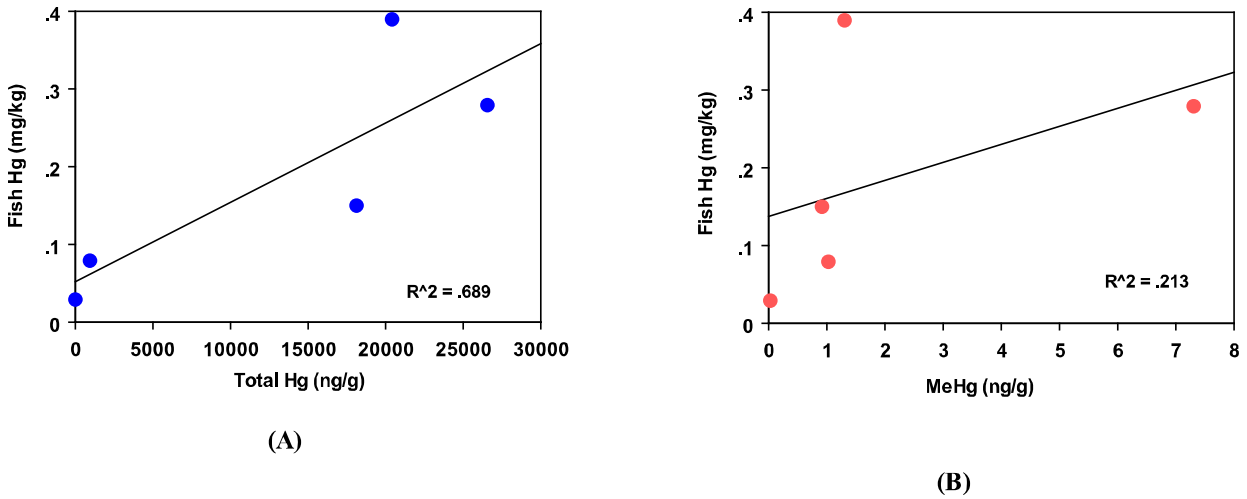


Figure 5-12. Relationship between mercury concentrations in California Roach and total mercury (A) and methylmercury (B) concentrations in sediment samples.

The fish sampling program conducted in 2004 combines the results from several field and laboratory efforts where different species, size ranges, and locations were sampled. The results of the fish sampling and measurements of mercury in tissue samples provides valuable new information to support the use of fish tissue as a numeric target for the TMDL. Fish tissue mercury concentrations have been shown to be elevated within the watershed, and the reported concentrations represent a potential risk to human consumption and wildlife predators. A baseline for fish mercury concentrations in the watershed has been established. Age-1 largemouth bass and California roach have been shown to be sensitive biosentinels that can be used to monitor recovery in the streams and reservoirs of the watershed. The relationship between mercury in fish tissue and methylmercury concentrations in the water column has been quantified, and the results indicate the ability to develop an aqueous methylmercury target in addition to a fish-tissue target for this TMDL.

6.0 RECOMMENDATIONS FROM THE DRY WEATHER SAMPLING

Data on total and methylmercury collected during the dry season, in conjunction with flow data collected by the SCVWD, were used to calculate internal and exported loads from the reservoirs. These calculations showed that the reservoirs are net producers and exporters of methylmercury to the downstream watershed, and net sinks for total mercury. This finding was largely consistent with the wet weather findings, although the production and export of methylmercury is significantly greater during the dry season. Much of the methylmercury generated in the reservoirs was produced in the hypolimnion, which is where the withdrawals for downstream supply take place. Methylmercury exports to Guadalupe and Alamitos creeks were an order of magnitude greater in the dry season than in the wet season.

The frequency of data collection, 6 times over a fourteen-week period, demonstrated clearly the gradual buildup of methylmercury in the hypolimnion of Almaden and Guadalupe Reservoirs. It appears from these measurements that there are some differences in the quantity of methylmercury produced among the two reservoirs studied (Guadalupe produces more methylmercury than Almaden), and in future sampling, sediment mercury and methylmercury measurements need to be made to better understand these differences. It is also recommended that similar measurements be made in the other two reservoirs in the watershed. To make such sampling more focused, they need only be conducted late in the dry season when the stratification is complete.

The most significant production of methylmercury occurs when the hypolimnion is anoxic. This is likely to minimize the number of fish and other aquatic organisms in this zone, and limit the transfer of methylmercury to the higher trophic levels *while the stratification is in place*. However, once the surface temperatures drop and the hypolimnion and epilimnion mix, there is a period when the methylmercury levels in and oxygen levels are higher in the entire volume of the reservoir. After this initial mixing, perhaps on the order of days, net methylmercury concentrations will decline because of demethylmation. It is likely that, during this relatively short period there

is significantly enhanced methylmercury supply to the entire food web. Unfortunately, there is limited data on methylmercury during this dynamic phase, and a focused study to better understand it is strongly recommended.

In future work, the seasonality of methylmercury production and export in the reservoirs, and the fact that most of the methylmercury is produced in the hypolimnion, may become the basis of potential management actions to reduce both production and export of methylmercury. Potential management actions, with consideration for non-mercury constraints, will be explored in a future task as part of this TMDL.

The results of the fish-sampling program support the use of fish tissue as a numeric target for the TMDL. The mercury concentrations in fish tissue exhibit distinct patterns within the watershed that can be related to the proximity to known mercury sources. The mercury concentrations in fish tissue also exhibit low variability within the size classes sampled at each reservoir. The low variability associated with these measurements indicates the feasibility of detecting statistically significant changes in fish mercury concentrations in response to changes in exposure conditions in the aquatic environment. However, there were small differences in the size classes of the largemouth bass samples collected in 2004 between sampling locations. The differences in fish length between sampling locations and sampling events should be minimized in future sampling events.

Fish mercury concentrations are positively correlated with the methylmercury concentrations measured in the reservoirs and streams in the watershed. These results indicate the ability to develop an aqueous methylmercury target for the Guadalupe Watershed Mercury TMDL. While numerous measurements of methylmercury were made in the Guadalupe and Almaden Reservoirs, fewer measurements were made at the other reservoirs and in the streams. The methylmercury concentrations in the water column should be better characterized at these other locations to minimize the uncertainty associated with the efficacy of selected numeric targets.

7.0 REFERENCES

ALERT Data System, 2004. On-line Retrieval System of the Santa Clara Valley Water District. (http://alert/valleywater.org)

Bhattacharyya, G. and R. Johnson. 1977. Statistical Concepts and Methods. John Wiley & Sons, New York, 639 pages.

Bloom, NS, 1994. "Influence of Analytical conditions on the Observed Reactive Mercury Concentrations in Natural Freshwaters". Proceedings of the 2nd International Conference on Mercury as an Environmental Pollutant (Lewis Publishers, Boca Raton, Florida. Pp. 541-552).

Froese, R. and D. Pauly (Eds.), 2004. FishBase. World Wide Web electronic publication. http://www.fishbase.org, version (06/2004).

Kuwabara, J., et al. 2004. Phytoplankton and zooplankton sampling in reservoirs of the Guadalupe River Watershed, personal communication.

Light, Air, & Space Construction (LAS), 2004. Water and Sediment Sampling at Almaden Reservoir and outlet. Prepared for the Santa Clara Valley Water District.

Moyle, P. B., 2002. Inland Fishes of California, University of California Press, Ltd.

SCVWD, 2004. Stream fish tissue collection and analysis report for total mercury content in Lavinia symmetricus 2004, Santa Clara Valley Water District.

SFBRWQCB, 2004. Surface Water Ambient Monitoring Program (SWAMP) San Francisco Bay Region. Chemical concentrations in fish tissues from selected reservoirs and coastal areas. Draft Report, San Francisco Bay Regional Water Quality Control Board.

Tetra Tech. 2003a. Technical Memorandum 2.1.2 Synoptic Survey Plan. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. July 30, 2003.

Tetra Tech. 2003b. Technical Memorandum 2.2 Synoptic Survey Report. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. September 8, 2003.

Tetra Tech. 2003c. Technical Memorandum 1.2 Preliminary Problem Statement. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. June 13, 2003.

Tetra Tech, 2003d. Technical Memorandum 7.4.2 Quality Assurance Plan. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District.

Tetra Tech, 2004a. Technical Memorandum 5.3.1 Draft Data Collection Report Part 1: Wet Season Sampling. Prepared for Santa Clara Valley Water District. June 23, 2004.

Tetra Tech. 2004b. Technical Memorandum 4.3 Draft Final Conceptual Model. Guadalupe River Watershed Mercury TMDL Project. Prepared for Santa Clara Valley Water District. June 7, 2004.

Tetra Tech, 2004c. Technical Memorandum 5.2.3 Data Collection Plan. Prepared for Santa Clara Valley Water District. February 20, 2004.

Tremblay, G., P. Legendre, et al., 1998. The use of polynomial regression analysis with indicator variables for interpretation of mercury in fish data. Biogeochemistry 40: 189-201.

USEPA. 2004. Guadalupe Watershed Reservoir Fish Sampling Plan, Draft 5/18/04, U. S. Environmental Protection Agency, Region 9.

APPENDIX A SAMPLING LOCATIONS

Station ID	Station Name	Depth, ft	Latitude	Longitude	Media Type
E7-4	Almaden Reservoir - epilimnion	1	37.1641	-121.8292	Water
E7-5	Almaden Reservoir - hypolimnion	50	37.1641	-121.8292	Water
E7-6	Almaden Reservoir Outlet	surface	37.1659	-121.8284	Water
E7-1	Guadalupe Reservoir - epilimnion	1	37.1979	-121.8775	Water
E7-2	Guadalupe Reservoir - hypolimnion	50	37.1979	-121.8775	Water
E7-3	Guadalupe Reservoir Outlet	surface	37.1994	-121.8811	Water

Multiple depth samples were collected on two dates: July 15 and August 2, 2004.

APPENDIX B QA/QC SUMMARY

A QA/QC Plan (QAPP) (Tetra Tech, 2003e) was prepared to guide the field programs and laboratory analyses. The results of the laboratory QA/QC program are summarized here for the water analyses.

Aqueous Samples

QA/QC procedures in the Data Collection Plan and QAPP (Tetra Tech, 2004 and 2003e) for collecting and analyzing water samples were followed. The QA/QC results for the mercury analyses showed that the desired detection limits were achieved and verified with method blank analyses. The resulting reporting limits were 0.15 ng/L for total mercury and 0.025 ng/L for methylmercury for most data sets (July 15, August 2, 12, and 31 samples). The mean total mercury and methylmercury concentrations were 0.08 ng/L and 0.04 ng/L, respectively for the June samples, and 0.15 ng/L and 0.019 ng/L for the May samples. For the May and June samples, two of the seven blanks for methylmercury had higher values (0.106 and 0.087 ng/L); these were excluded from the mean calculation by the laboratory. Two filter blanks were run; one had the same reporting limits as the blank samples. The other sample had higher concentrations in the filtrate (0.57 ng/L) than the unfiltered portion (0.25 ng/L), but both were less than the actual filtered mercury concentrations. This high filtrate was considered an outlier, because the filtered equipment blank that was run on the same date, had the same concentration of total mercury as the filter blank (0.25 ng/L). Two equipment blanks were run. The sample at the beginning of the summer had low total and dissolved mercury (0.22 ng/L and 0.25 ng/L), but no methylmercury (<0.025 ng/L). The sample at the end of the summer had low total mercury (0.54 ng/L), and no dissolved mercury (<0.15 ng/L) and no methylmercury (<0.025 ng/L). Thus, the pump and tubing equipment is not considered to be contaminating the samples.

Two laboratory duplicates of one or two samples per sampling event were analyzed to check precision of the water analyses for all the mercury species. The relative percent difference (RPD) for total mercury in these duplicates ranged from 0.0 to 9.0 percent, which is within the acceptable range of plus or minus 25 percent. The RPDs

for methylmercury ranged from 0.1 to 13.9 percent, which is within the desired limits of 30 percent for methylmercury. There was one replicate sample with a high RPD for methylmercury (41.1 percent for QC2 on 8/2/04); this sample was not a freshwater sample from the study reservoirs, and it had low concentrations (0.06 to 0.09 ng/L). Because the difference was less than two times the reporting limit, it was not considered significant with respect to the actual samples. A total of 11 matrix spike samples were analyzed for total and methylmercury; percent recoveries for total mercury ranged from 95.9 to 1100.4 percent, while the RPDs were from 0.0 to 9.7 percent, both within acceptable limits. Six analyses of certified reference materials were also performed: the materials used were NIST-1641d for total mercury and DORM-2 for methylmercury. The percent recoveries for total mercury varied from 84.8 to 103.0 percent and 81.0 to 121.4 percent for methylmercury, which are within the desired limits of 25 percent for total mercury and 30 percent for methylmercury.

In addition to the above laboratory analyses, six field replicates were collected and analyzed to provide information on the variability contributed by differing field conditions. The variability increased when more suspended solids (> 5 mg/L) were present. All mercury data were considered usable.

For the other water quality parameters, method blank samples, duplicates, blank spike, and matrix spike samples were analyzed. The parameters were nutrients (ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, and chlorophyll-a), DOC, sulfate, and sulfide. All method blanks for these parameters were not detected. The method detection limit for sulfate was 1 mg/L, which was less than the actual samples (12 to 19 mg/L). The replicate samples for sulfate were equal for all six pairs. The method detection limit for sulfide was 0.01 mg/L. Both sulfate and sulfide analyses met the respective QA/QC criteria. There were two total phosphorus samples that were rechecked by the laboratory and then rerun from one date (8/2/04), because the results were not representative. The rerun results were an order of magnitude less, similar to the other concentrations. Both data sets are reported, but the unusual high values from the original data were not used for the data analyses. The laboratory did not achieve the desired low detection limit for chlorophyll-a; the results were discussed with the laboratory, but a reason was not provided. Nitrite was not detected in any of the water samples, but the QA/QC criteria were met. The QA/QC criteria for the other parameters were acceptable.

APPENDIX C MERCURY RESULTS IN WATER AND FISH

The mercury sampling results for water and fish samples from the laboratory are provided here for the dry season samples from the reservoirs collected in 2004.

Aqueous Mercury Speciation in Guadalupe River System, Spring 2004 (Tetra-Tech)
analyzed by
Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA phone: 206-622-6960 e-mail: nicolasb@nickslab.org
total Hg by BrCl digestion + SnCl2 reduction, dual amalgamation CVAFS; CH3Hg by distillation extraction + aqueous ethylation + GC-CVAFS

	sampling			TOTAL MERCURY					METHYL MERCURY					
sample ID	date	time	TSS mg L^{-1}	analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	Analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	comments
E7-03a	11-May-04	14:00	9.4	14-May-04	34.0	4.35	3,167	5.86	14-May-04	0.853	0.552	32.2	4.77	
E7-03b	11-May-04	14:00	10.7	14-May-04	21.1	4.01	1,596	5.60	14-May-04	0.972	0.633	31.7	4.70	
E7-01	11-May-04	8:30	1.9	14-May-04	13.7	2.19	6,047	6.44	14-May-04	0.566	0.171	208	6.08	
E7-02	11-May-04	8:30	6.1	14-May-04	18.4	5.25	2,162	5.61	14-May-04	0.463	0.247	35.4	5.16	
E7-04	11-May-04	11:55	0.8	14-May-04	3.54	1.86	2,100	6.05	14-May-04	0.336	0.164	215	6.12	
E7-05	11-May-04	12:20	1.3	14-May-04	4.10	1.72	1,859	6.03	14-May-04	0.518	0.298	172	5.76	
E7-06	11-May-04	10:25	1.4	14-May-04	7.69	3.47	2,951	5.93	14-May-04	2.271	1.219	736	5.78	
E-Blank	11-May-04	4:45	0.0	14-May-04	0.22	0.25			14-May-04	-0.026	-0.037			
blank-01			0.00	14-May-04	0.02				14-May-04	*0.106*				*blank excluded from mean*
blank-02			0.00	14-May-04	-0.01				14-May-04	0.025				
blank-03			0.00	14-May-04	0.03				14-May-04	0.045				
blank-04			-0.05	14-May-04	0.01				14-May-04	*nd*				
mean			-0.01		0.01					0.035				
eMDL			0.08		0.05					0.042				
filter blank				14-May-04	0.25	0.57			14-May-04	0.024	-0.035			

	sampling			TOTAL MERCURY					METHYL MERCURY					
sample ID	date	time	TSS mg L^{-1}	analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	Analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	comments
dup. sample			E7-06		E7-03b					E7-06				
replicate 1			1.45	14-May-04	21.8				14-May-04	2.303				
replicate 2			1.40	14-May-04	20.4				14-May-04	2.238				
mean			1.43	14-May-04	21.1				14-May-04	2.271				
RPD (%)			3.5	14-May-04	6.7				14-May-04	2.9				
spiked sample					E7-06					E7-06 diss				
spike level				14-May-04	20.20				14-May-04	1.667				
sample + spike				14-May-04	27.24				14-May-04	2.658				
% recovery				14-May-04	96.8				14-May-04	86.3				
spl + spike dup				14-May-04	27.07				14-May-04	2.929				
% recovery				14-May-04	95.9				14-May-04	102.6				
mean				14-May-04	27.16				14-May-04	2.79				
RPD (%)				14-May-04	0.6				14-May-04	9.7				
ref. material					NIST-1641					DORM-2				
measured				14-May-04	6,790				14-May-04	4,016				
certified				14-May-04	8,010				14-May-04	4,470				
% recovery				14-May-04	84.8				14-May-04	89.8				

Aqueous Mercury Speciation in Guadalupe River System, June 2004 (Tetra-Tech)
analyzed by
Frontier Geosciences Aquatic Geochemistry Group 414 Pontius North Seattle, WA 98109 USA phone: 206-622-6960 e-mail: nicolasb@nickslab.org
total Hg by aqua regia digestion + SnCl2 reduction, dual amalgamation CVAFS; CH3Hg by HBr/CH2Cl2 extraction + aqueous ethylation + GC-CVAFS

	sampling			TOTAL MERCURY					METHYL MERCURY					
sample ID	date	time	TSS mg L^{-1}	Analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	Analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	comments
E7-1	10-Jun-04	12:22	4.1	14-Jun-04	42.8	1.73	10,017	6.76	22-Jun-04	0.472	0.157	76.83	5.69	
E7-2	10-Jun-04	12:30	2.5	14-Jun-04	19.7	3.29	6,564	6.30	22-Jun-04	0.424	0.226	79.20	5.54	
E7-3	10-Jun-04	13:41	7.8	14-Jun-04	33.4	3.36	3,851	6.06	22-Jun-04	1.240	0.772	60.00	4.89	
E7-4	10-Jun-04	14:45	1.4	14-Jun-04	4.09	1.32	1,979	6.18	22-Jun-04	0.506	0.333	123.6	5.57	
E7-5	10-Jun-04	14:45	3.4	14-Jun-04	4.68	2.22	724	5.51	22-Jun-04	1.287	0.817	138.2	5.23	
E7-6a	10-Jun-04	16:45	2.4	14-Jun-04	7.82	2.65	2,154	5.91	22-Jun-04	2.771	1.584	494.6	5.49	
E7-6b	10-Jun-04	16:45	2.5	14-Jun-04	7.25	2.29	1,984	5.94	22-Jun-04	2.909	1.515	557.6	5.57	
blank-01			0.07	14-Jun-04	0.03				22-Jun-04	*0.087*				methyl blank-1 excluded from mean blank calculation
blank-02			0.13	14-Jun-04	0.04				22-Jun-04	0.046				
blank-03			0.03	14-Jun-04	0.04				22-Jun-04	0.037				
blank-04			*n/a*	14-Jun-04	0.02					*n/a*				
mean			0.08		0.03					0.041				
eMDL			0.15		0.03					0.019				
dup. sample			E7-4		E7-2 UF					E7-6a UF				
replicate 1			1.47	14-Jun-04	20.60				22-Jun-04	2.891				
replicate 2			1.33	14-Jun-04	18.83				22-Jun-04	2.652				
mean			1.40		19.71					2.771				
RPD (%)			9.5		9.0					8.6				

	sampling			TOTAL MERCURY					METHYL MERCURY					
sample ID	date	time	TSS mg L^{-1}	Analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	Analysis date	UF ng L^{-1}	0.4 µ filt ng L^{-1}	Susp ng g^{-1}	log K_d	comments
spiked sample					E7-2 UF					E7-6b				
spike level (MS)					60.61					2.000				
sample + spike				14-Jun-04	84.82				22-Jun-04	5.064				
% recovery					107.4					107.8				
spike level (MSD)					60.61					2.101				
spl + spike dup				14-Jun-04	84.49				22-Jun-04	5.350				
% recovery					106.9					116.2				
mean % recovery					107.2					112.0				
RPD (%)				14-Jun-04	0.4					7.5				
ref. material					NIST-1641d					DORM-2				
measured				14-Jun-04	7,273				22-Jun-04	3,619				
certified					8,010					4,470				
% recovery					90.8					81.0				

Mercury Speciation Results for Tetra Tech
Reported September 1, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109
Revised on October 5, 2004

Sample Results

Sample ID	Date Collected	Batch ID	Total Hg (ng/L)	Dissolved Total Hg (ng/L)	Batch ID	Methyl Hg (ng/L)	Dissolved Methyl Hg (ng/L)	Batch ID	TSS (mg/L)
E7-1	8/2/04	A	11.0	1.50	B	0.204	0.128	E	3.0
E7-2	8/2/04	A	6.55	3.60	B	3.81	3.58	E	2.0
E7-3	8/2/04	A	14.7	4.40	D,Ba	6.43	3.73	E	6.0
E7-4a	8/2/04	A	4.17	1.62	B	0.582	0.287	E	1.7
E7-4b	8/2/04	A	4.22	1.35	B	0.511	0.233	E	2.0
E7-5	8/2/04	A	4.07	1.33	B	2.07	1.07	E	3.5
E7-6	8/2/04	A	20.8	2.33	B	4.15	2.38	E	3.0
E7-7	8/2/04		-b	-b		-b	-b	E	10.0
E7-8	8/2/04	A	18.2	2.91	C	0.360	0.152	E	3.0
E7-9	8/2/04	A	31.0	4.76	C	0.585	0.145	E	2.0
E7-10	8/2/04	A	29.3	7.11	C	4.99	4.15	E	8.0
E7-11	8/2/04	A	4.92	1.66	C	0.644	0.272	E	2.3
E7-12	8/2/04	A	15.1	4.22	C	0.585	0.250	E	1.0
E7-13	8/2/04	A	4.71	2.83	C	0.526	0.357	E	< 1.0
E7-14	8/2/04	A	19.8	1.79	C	0.985	0.684	E	1.5

a Sample E7-3 for total Methyl Mercury was analyzed by batch D, the dissolved fraction by Batch B. Please see the analytical issues section of the case narative.

b No sample submitted. Please see Chain of Custody

Mercury Speciation Results for Tetra Tech
Reported September 1, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109

Quality Control Data - Matrix Duplicate Report

Analyte (ng/L)	Batch	Sample QC'd	Rep. 1	Rep. 2	Mean	RPD
Total Hg	A	E7-4a-T	4.17	4.14	4.16	0.8
	A	E7-8-T	18.22	18.26	18.24	0.2
Methyl Hg	B	E7-1-T	0.204	0.233	0.219	13.2
	C	E7-8-T	0.360	0.413	0.387	13.9
	D	Batch QC1	1.526	1.527	1.527	0.1
	D	Batch QC2	0.091	0.060	0.076	41.1[a]
TSS	E	E7-1	3.0	2.5	2.8	18.2
	E	E7-10	8.0	9.0	8.5	11.8

RPD = Relative Percent Difference between Replicate results
[a] RPD is above the control limit of 25%. Please see the analytical issues section of the case narative.
QC2 sample was not freshwater, difference was less than 2X RL, so not analytically significant.

Quality Control Data - Matrix Spike / Matrix Spike Duplicate Report

Analyte (ng/L)	Batch	Sample QC'd	Sample Mean	Spike Level	MS	% Rec.	Spike Level	MSD	% Rec.	RPD
Total Hg	A	E7-5-T	4.07	20.41	26.53	110.1	20.41	26.43	109.6	0.5
	A	E7-10-T	29.25	81.63	119.8	110.9	81.63	119.4	110.4	0.5
Methyl Hg	B	E7-2-T	3.806	1.669	5.408	96.0	1.661	5.713	114.8	17.8
	C	E7-13-T	0.526	1.666	2.118	95.6	1.666	2.071	92.7	3.0
	D	Batch QC1	1.527	7.895	7.499	75.6	9.336	8.869	78.6	3.9
	D	Batch QC2	0.075	9.375	8.810	93.2	9.375	8.534	90.2	3.2

MS = Matrix Spike
MSD = Matrix Spike Duplicate
RPD = Relative Percent Difference between % Recovery values

Quality Control Data - Preparation Blank Report

Analyte (ng/L)	Batch	PBW1	PBW2	PBW3	Mean	St. Dev.	R.L.
Total Hg	A	-0.03	0.09	0.11	0.06	0.08	0.15
Methyl Hg	B	-0.001	0.000	0.000	0.000	0.001	0.025
	C	0.010	0.011	0.007	0.010	0.002	0.025
	D	0.003	0.003	0.003	0.003	0.000	0.025
TSS	E	0.0	0.2	0.2	0.11	0.1	1.0

St. Dev. = Standard Deviation
R.L. = Reporting Limit

Quality Control Data - Certified Reference Materials Report

Analyte (ng/L)	Batch	CRM Identity	Cert. Value	Obs. Value	% Rec.
Total Hg	A	NIST 1641d	1601000	1575000	98.4
Methyl Hg	B	DORM-2	4470	4297	96.1
	C	DORM-2	4470	4368	97.7
	D	DORM-2	4470	4137	92.6

CRM Identity = Certified reference material identity
Cert. Value = Certified value
Obs. Value = Experimental result
% Rec. = Percent recovery

Mercury Speciation Results for Tetra Tech
Reported September 11, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109

Sample Results

		Total Hg (ng/L)		Methyl Hg (ng/L)		
Sample ID	**Date Collected**	**Total**	**Dissolved**	**Total**	**Dissolved**	**TSS (mg/L)**
E7-1	8/12/04	13.2	1.44	0.324	0.117	3.5
E7-2A	8/12/04	32.3	9.88	11.0	8.27	7.5
E7-2B	8/12/04	26.0	7.32	5.09	5.47	7.0
E7-3	8/12/04	19.8	8.60	8.10	6.08	4.5
E7-4	8/12/04	3.25	1.12	0.466	0.237	1.3
E7-5	8/12/04	10.5	4.06	1.83	2.81	3.0
E7-6	8/12/04	12.7	1.85	7.20	4.29	4.0

Mercury Speciation Results for Tetra Tech
Reported September 11, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109

Quality Control Data- Matrix Duplicate Report

Analyte (ng/L)	Sample QC'd	Rep.1	Rep. 2	Mean	RPD
Total Hg	E7-2A	32.32	33.14	32.73	2.5
Methyl Hg	E7-2A	10.99	9.831	10.41	11.2
TSS	E7-5	3.0	3.0	3.0	0.0

Quality Control Data- Matrix Spike / Matrix Spike Duplicate Report

Analyte (ng/L)	Sample Qc'd	Sample Mean	Spike Level	MS	%Rec.	MSD	%Rec.	RPD
Total Hg	E7-2B	26.00	80.81	103.7	96.2	104.2	96.7	0.4
Methyl Hg	E7-3	8.104	8.832	15.58	84.7	16.54	95.5	6.0

MS = Matrix Spke
MSD = Matrix Spike Duplicate
RPD = Relative Percent Difference

Mercury Speciation Results for Tetra Tech
Reported September 11, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109

Quality Control Data – Preparation Blank Report

Analyte (ng/L)	PBW1	PBW2	PBW3	Mean	St. Dev.	R.L.
Total Hg	0.06	0.04	0.05	0.05	0.01	0.15
Methyl Hg	0.015	0.011	0.013	0.013	0.002	0.025
TSS	0.0	0.2	0.2	0.0	0.1	1.0

St. Dev. = Standard Deviation
R.L. = Reporting Limit

Quality Control Data – Certified Reference Materials Report

Analyte (ng/L)	CRM Identity	Cert. Value	Obs. Value	% Rec.
Total Hg	NIST 1641d	1601000	1649000	103.0
Methyl Hg	DORM-2	4470	5427	121.4

CRM Identity = Certified reference material identity
Cert. Value = Certified value
Obs. Value = Experimental result
%Rec. = Percent recovery

Mercury Speciation Results for Tetra Tech
Reported September 30, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109
Revised on October 5, 2004

Sample Results

		Total Hg (mg/L)		Methyl Hg (mg/L)		
Sample ID	Date Collected	Total	Dissolved	Total	Dissolved	TSS (mg/L)
E7-1	8/31/04	11.8	1.00	0.272	0.085	4.5
E7-2	8/31/04	39.4	11.0	11.5	7.50	9.0
E7-3	8/31/04	49.2	12.2	12.8	7.24	11.5
E7-4	8/31/04	2.93	1.12	0.369	0.277	4.0
E7-5a	8/31/04	12.3	3.08	5.49	3.09	4.0
E7-5b	8/31/04	11.0	3.53	5.09	2.68	2.0
E7-0	8/31/04	0.54	<0.15	<0.025	<0.025	<1.0
E7-6	8/31/04	14.3	3.48	6.47	3.69	3.5

Mercury Speciation Results for Tetra Tech
Reported September 30, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109

Quality Control Data – Matrix Duplicate Report

Analyte (ng/L)	Sample QC'd	Rep.1	Rep.2	Mean	RPD
Total Hg	E7-2	39.36	37.60	38.48	4.6
Methyl Hg	E7-2	11.47	11.46	11.46	0.1
TSS	E7-2	90.0	95.0	92.5	5.4

Quality Control Data – Matrix Spike / Matrix Spike Duplicate Report

Analyte (ng/L)	Sample QC'd	Sample Mean	Spike Level	MS	%Rec.	MSD	%Rec.	RPD
Total Hg	E7-6	14.26	52.63	67.71	101.5	65.76	97.8	2.9
Methyl Hg	E7-3	12.83	17.75	32.50	103.4	26.77	78.5	15.3

MS = Matrix Spike
MSD = Matrix Spike Duplicate
RPD = Relative Percent Difference

Mercury Speciation Results for Tetra Tech
Reported September 30, 2004
Frontier Geosciences Inc., 414 Pontius Ave. N, Seattle WA 98109

Quality Control Data – Preparation Blank Report

Analyte (ng/L)	PBW1	PBW2	PBW3	Mean	St. Dev.	R.L.
Total Hg	0.08	0.06	0.07	0.07	0.01	0.15
Methyl Hg	0.006	0.009	0.002	0.006	0.004	0.025
TSS	0.0	-2.5	2.5	0.0	2.5	1.0

St. Dev. = Standard Deviation
R.L. = Reporting Limit

Quality Control Data – Certified Reference Materials Report

Analyte (ng/L)	CRM Identity	Cert. Value	Obs. Value	%Rec.
Total Hg	NIST 1641d	1601000	1527000	95.4
Methyl Hg	DORM-2	4470	5034	112.6

CRM Identity = Certified reference material identity
Cert. Value = Certified Value
Obs. Value = Experimental result
% Rec. = Percent recovery

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252E

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252E
Reported: 10/13/04 15:04

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
LR-21	0409030-12	Tissue	09/08/04 15:00	09/08/04 19:30
LR-22	0409030-13	Tissue	09/08/04 15:00	09/08/04 19:30
LR-23	0409030-14	Tissue	09/08/04 15:00	09/08/04 19:30
LR-24	0409030-15	Tissue	09/08/04 15:00	09/08/04 19:30
LR-25	0409030-16	Tissue	09/08/04 15:00	09/08/04 19:30
LR-26	0409030-17	Tissue	09/08/04 15:00	09/08/04 19:30
LR-27	0409030-18	Tissue	09/08/04 15:00	09/08/04 19:30
LR-28	0409030-19	Tissue	09/08/04 15:00	09/08/04 19:30
LR-29	0409030-20	Tissue	09/08/04 15:00	09/08/04 19:30
LR-30	0409030-21	Tissue	09/08/04 15:00	09/08/04 19:30
LR-31	0409030-22	Tissue	09/08/04 15:00	09/08/04 19:30
LR-32	0409030-23	Tissue	09/08/04 15:00	09/08/04 19:30
LR-33	0409030-24	Tissue	09/08/04 15:00	09/08/04 19:30
LR-34	0409030-25	Tissue	09/08/04 15:00	09/08/04 19:30
LR-35	0409030-26	Tissue	09/08/04 15:00	09/08/04 19:30
LR-36	0409030-27	Tissue	09/08/04 15:00	09/08/04 19:30
LR-37	0409030-28	Tissue	09/08/04 15:00	09/08/04 19:30
LR-38	0409030-29	Tissue	09/08/04 15:00	09/08/04 19:30
LR-39	0409030-30	Tissue	09/08/04 15:00	09/08/04 19:30
LR-40	0409030-31	Tissue	09/08/04 15:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:04
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409030-12**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-21**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.33**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-13**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-22**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.42**		**0.13**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**19**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-14**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-23**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.55**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-15**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-24**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.53**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**23**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-16**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-25**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.40**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**23**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-17**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-26**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.42**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-18**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-27**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.52**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-19**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-28**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.40**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-20**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-29**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.47**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0051	10/11/04	10/12/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:04
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409030-21**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-30**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.45**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-22**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-31**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.50**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**23**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-23**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-32**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.39**		**0.13**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**19**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-24**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-33**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.35**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-25**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-34**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.47**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-26**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-35**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.32**		**0.14**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**18**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-27**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-36**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.52**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-28**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-37**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.34**		**0.13**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**19**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: **0409030-29**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-38**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.51**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0051	10/11/04	10/12/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:04
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409030-30								Tissue - Sampled: 09/08/04 15:00
Sample ID: LR-39								Metals by EPA 6000/7000 Series Methods
Mercury	**0.70**		**0.12**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0051	10/11/04	10/12/04	% calculation
Lab ID: 0409030-31								Tissue - Sampled: 09/08/04 15:00
Sample ID: LR-40								Metals by EPA 6000/7000 Series Methods
Mercury	**0.37**		**0.11**	mg/kg dry	B4J0039	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0051	10/11/04	10/12/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:04
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 10/07/04	
Batch B4J0039 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4J0039-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4J0039-DUP1)	**Source: 0409030-15**									
Mercury	0.57		0.11	mg/kg dry		0.53			7	20
Duplicate (B4J0039-DUP2)	**Source: 0409030-27**									
Mercury	0.56		0.12	mg/kg dry		0.52			7	20
Reference (B4J0039-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4J0039-SRM2)										
Mercury	0.45		0.025	mg/kg wet	0.433		104	80-120		
									Prepared: 10/11/04 Analyzed: 10/12/04	
Batch B4J0051 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4J0051-BLK1)										
% Solids	0			%						
Duplicate (B4J0051-DUP1)	**Source: 0409030-12**									
% Solids	23			%		21			9	20

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/13/04 15:04
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252A

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252A
Reported: 10/14/04 10:21

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
LA-21	0409026-21	Tissue	08/31/04 13:00	09/08/04 19:30
LA-22	0409026-22	Tissue	08/31/04 13:00	09/08/04 19:30
LA-23	0409026-23	Tissue	08/31/04 13:00	09/08/04 19:30
LA-24	0409026-24	Tissue	08/31/04 13:00	09/08/04 19:30
LA-25	0409026-25	Tissue	08/31/04 13:00	09/08/04 19:30
LA-26	0409026-26	Tissue	08/31/04 13:00	09/08/04 19:30
LA-27	0409026-27	Tissue	08/31/04 13:00	09/08/04 19:30
LA-28	0409026-28	Tissue	08/31/04 13:00	09/08/04 19:30
LA-29	0409026-29	Tissue	08/31/04 13:00	09/08/04 19:30
LA-30	0409026-30	Tissue	08/31/04 13:00	09/08/04 19:30
LA-31	0409026-31	Tissue	08/31/04 13:00	09/08/04 19:30
LA-32	0409026-32	Tissue	08/31/04 13:00	09/08/04 19:30
LA-33	0409026-33	Tissue	08/31/04 13:00	09/08/04 19:30
LA-34	0409026-34	Tissue	08/31/04 13:00	09/08/04 19:30
LA-35	0409026-35	Tissue	08/31/04 13:00	09/08/04 19:30
LA-36	0409026-36	Tissue	08/31/04 13:00	09/08/04 19:30
LA-37	0409026-37	Tissue	08/31/04 13:00	09/08/04 19:30
LA-38	0409026-38	Tissue	08/31/04 13:00	09/08/04 19:30
LA-39	0409026-39	Tissue	08/31/04 13:00	09/08/04 19:30
LA-40	0409026-40	Tissue	08/31/04 13:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252A
Reported: 10/14/04 10:21

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409026-21								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-21								Metals by EPA 6000/7000 Series Methods
Mercury	**2.4**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-22								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-22								Metals by EPA 6000/7000 Series Methods
Mercury	**1.7**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-23								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-23								Metals by EPA 6000/7000 Series Methods
Mercury	**2.4**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-24								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-24								Metals by EPA 6000/7000 Series Methods
Mercury	**1.8**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-25								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-25								Metals by EPA 6000/7000 Series Methods
Mercury	**1.6**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-26								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-26								Metals by EPA 6000/7000 Series Methods
Mercury	**1.8**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-27								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-27								Metals by EPA 6000/7000 Series Methods
Mercury	**1.8**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-28								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-28								Metals by EPA 6000/7000 Series Methods
Mercury	**2.1**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-29								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-29								Metals by EPA 6000/7000 Series Methods
Mercury	**1.4**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0057	10/12/04	10/13/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252A
Reported: 10/14/04 10:21

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409026-30								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-30								Metals by EPA 6000/7000 Series Methods
Mercury	**1.9**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**23**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-31								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-31								Metals by EPA 6000/7000 Series Methods
Mercury	**1.6**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-32								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-32								Metals by EPA 6000/7000 Series Methods
Mercury	**2.0**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-33								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-33								Metals by EPA 6000/7000 Series Methods
Mercury	**2.3**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-34								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-34								Metals by EPA 6000/7000 Series Methods
Mercury	**1.3**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-35								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-35								Metals by EPA 6000/7000 Series Methods
Mercury	**2.4**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-36								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-36								Metals by EPA 6000/7000 Series Methods
Mercury	**1.0**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-37								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-37								Metals by EPA 6000/7000 Series Methods
Mercury	**1.8**		**0.11**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-38								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-38								Metals by EPA 6000/7000 Series Methods
Mercury	**1.6**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 10:21
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409026-39								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-39								Metals by EPA 6000/7000 Series Methods
Mercury	**1.7**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation
Lab ID: 0409026-40								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-40								Metals by EPA 6000/7000 Series Methods
Mercury	**1.7**		**0.12**	mg/kg dry	B4J0047	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0057	10/12/04	10/13/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 10:21
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 10/11/04	
Batch B4J0047 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4J0047-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4J0047-DUP1)	**Source: 0409026-27**									
Mercury	1.9		0.12	mg/kg dry		1.8			5	20
Duplicate (B4J0047-DUP2)	**Source: 0409026-36**									
Mercury	0.88		0.12	mg/kg dry		1.0			13	20
Reference (B4J0047-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4J0047-SRM2)										
Mercury	0.41		0.025	mg/kg wet	0.433		95	80-120		
									Prepared: 10/12/04 Analyzed: 10/13/04	
Batch B4J0057 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4J0057-BLK1)										
% Solids	0			%						
Duplicate (B4J0057-DUP1)	**Source: 0409026-39**									
% Solids	21			%		21			0	20

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/14/04 10:21
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252B

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252B
Reported: 10/05/04 10:00

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
CR-01	0409027-01	Tissue	08/31/04 09:00	09/08/04 19:30
CR-02	0409027-02	Tissue	08/31/04 09:00	09/08/04 19:30
CR-03	0409027-03	Tissue	08/31/04 09:00	09/08/04 19:30
CR-04	0409027-04	Tissue	08/31/04 09:00	09/08/04 19:30
CR-05	0409027-05	Tissue	08/31/04 09:00	09/08/04 19:30
CR-06	0409027-06	Tissue	08/31/04 09:00	09/08/04 19:30
CR-07	0409027-07	Tissue	08/31/04 09:00	09/08/04 19:30
CR-08	0409027-08	Tissue	08/31/04 09:00	09/08/04 19:30
CR-09	0409027-09	Tissue	08/31/04 09:00	09/08/04 19:30
CR-10	0409027-10	Tissue	08/31/04 09:00	09/08/04 19:30
CR-11	0409027-11	Tissue	08/31/04 09:00	09/08/04 19:30
CR-12	0409027-12	Tissue	08/31/04 09:00	09/08/04 19:30
CR-13	0409027-13	Tissue	08/31/04 09:00	09/08/04 19:30
CR-14	0409027-14	Tissue	08/31/04 09:00	09/08/04 19:30
CR-15	0409027-15	Tissue	08/31/04 09:00	09/08/04 19:30
CR-16	0409027-16	Tissue	08/31/04 09:00	09/08/04 19:30
CR-17	0409027-17	Tissue	08/31/04 09:00	09/08/04 19:30
CR-18	0409027-18	Tissue	08/31/04 09:00	09/08/04 19:30
CR-19	0409027-19	Tissue	08/31/04 09:00	09/08/04 19:30
CR-20	0409027-20	Tissue	08/31/04 09:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252B
Reported: 10/05/04 10:00

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409027-01**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-01**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.8**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-02**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-02**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.5**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-03**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-03**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.7**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-04**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-04**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.9**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**20**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-05**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-05**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.5**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-06**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-06**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.4**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-07**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-07**								Metals by EPA 6000/7000 Series Methods
Mercury	**6.2**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-08**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-08**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-09**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-09**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.3**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/05/04 10:00
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409027-10**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-10**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.2**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-11**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-11**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-12**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-12**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.2**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-13**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-13**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.7**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-14**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-14**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.4**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-15**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-15**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.9**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-16**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-16**								Metals by EPA 6000/7000 Series Methods
Mercury	**6.9**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-17**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-17**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.3**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: **0409027-18**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-18**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.0**		**0.12**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0146	09/28/04	09/30/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/05/04 10:00
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409027-19								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-19								Metals by EPA 6000/7000 Series Methods
Mercury	**7.1**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: 0409027-20								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-20								Metals by EPA 6000/7000 Series Methods
Mercury	**6.2**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela	**Northern California Office**	**SDG:** 04252B	
Project Number: R04W05	**75 Hawthorne Street**	**Reported:** 10/05/04 10:00	
Project: South Bay Mercury TMDL	**San Francisco CA, 94105**		

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 09/28/04	
Batch B4I0141 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4I0141-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4I0141-DUP1)	**Source: 0409027-02**									
Mercury	4.5		0.11	mg/kg dry		4.5			0	20
Duplicate (B4I0141-DUP2)	**Source: 0409027-11**									
Mercury	5.1		0.12	mg/kg dry		5.0			2	20
Reference (B4I0141-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4I0141-SRM2)										
Mercury	0.40		0.025	mg/kg wet	0.433		92	80-120		
									Prepared: 09/28/04 Analyzed: 09/30/04	
Batch B4I0146 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4I0146-BLK1)										
% Solids	0			%						

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/05/04 10:00
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252B

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252B
Reported: 10/13/04 15:10

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
CR-19	0409027-19	Tissue	08/31/04 09:00	09/08/04 19:30
CR-20	0409027-20	Tissue	08/31/04 09:00	09/08/04 19:30
CR-21	0409027-21	Tissue	08/31/04 09:00	09/08/04 19:30
CR-22	0409027-22	Tissue	08/31/04 09:00	09/08/04 19:30
CR-23	0409027-23	Tissue	08/31/04 09:00	09/08/04 19:30
CR-24	0409027-24	Tissue	08/31/04 09:00	09/08/04 19:30
CR-25	0409027-25	Tissue	08/31/04 09:00	09/08/04 19:30
CR-26	0409027-26	Tissue	08/31/04 09:00	09/08/04 19:30
CR-27	0409027-27	Tissue	08/31/04 09:00	09/08/04 19:30
CR-28	0409027-28	Tissue	08/31/04 09:00	09/08/04 19:30
CR-29	0409027-29	Tissue	08/31/04 09:00	09/08/04 19:30
CR-30	0409027-30	Tissue	08/31/04 09:00	09/08/04 19:30
CR-31	0409027-31	Tissue	08/31/04 09:00	09/08/04 19:30
CR-32	0409027-32	Tissue	08/31/04 09:00	09/08/04 19:30
CR-33	0409027-33	Tissue	08/31/04 09:00	09/08/04 19:30
CR-34	0409027-34	Tissue	08/31/04 09:00	09/08/04 19:30
CR-35	0409027-35	Tissue	08/31/04 09:00	09/08/04 19:30
CR-36	0409027-36	Tissue	08/31/04 09:00	09/08/04 19:30
CR-37	0409027-37	Tissue	08/31/04 09:00	09/08/04 19:30
CR-38	0409027-38	Tissue	08/31/04 09:00	09/08/04 19:30
CR-39	0409027-39	Tissue	08/31/04 09:00	09/08/04 19:30
CR-40	0409027-40	Tissue	08/31/04 09:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252B
Reported: 10/13/04 15:10

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409027-19								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-19								Metals by EPA 6000/7000 Series Methods
Mercury	**7.1**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: 0409027-20								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-20								Metals by EPA 6000/7000 Series Methods
Mercury	**6.2**		**0.11**	mg/kg dry	B4I0141	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0146	09/28/04	09/30/04	% calculation
Lab ID: 0409027-21								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-21								Metals by EPA 6000/7000 Series Methods
Mercury	**1.1**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-22								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-22								Metals by EPA 6000/7000 Series Methods
Mercury	**0.78**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-23								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-23								Metals by EPA 6000/7000 Series Methods
Mercury	**1.9**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-24								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-24								Metals by EPA 6000/7000 Series Methods
Mercury	**1.5**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**21**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-25								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-25								Metals by EPA 6000/7000 Series Methods
Mercury	**0.57**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-26								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-26								Metals by EPA 6000/7000 Series Methods
Mercury	**0.64**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-27								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-27								Metals by EPA 6000/7000 Series Methods
Mercury	**0.83**		**0.13**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**19**			%	B4J0050	10/11/04	10/12/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:10
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409027-28**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-28**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.9**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-29**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-29**								Metals by EPA 6000/7000 Series Methods
Mercury	**1.0**		**0.13**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**19**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-30**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-30**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.96**		**0.11**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**22**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-31**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-31**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.88**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-32**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-32**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.65**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-33**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-33**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.93**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-34**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-34**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.77**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-35**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-35**								Metals by EPA 6000/7000 Series Methods
Mercury	**0.77**		**0.14**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**18**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: **0409027-36**								Tissue - Sampled: 08/31/04 09:00
Sample ID: **CR-36**								Metals by EPA 6000/7000 Series Methods
Mercury	**1.1**		**0.14**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**18**			%	B4J0050	10/11/04	10/12/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:10
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409027-37								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-37								Metals by EPA 6000/7000 Series Methods
Mercury	**1.2**		**0.15**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**17**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-38								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-38								Metals by EPA 6000/7000 Series Methods
Mercury	**1.2**		**0.14**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**18**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-39								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-39								Metals by EPA 6000/7000 Series Methods
Mercury	**0.50**		**0.12**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**20**			%	B4J0050	10/11/04	10/12/04	% calculation
Lab ID: 0409027-40								Tissue - Sampled: 08/31/04 09:00
Sample ID: CR-40								Metals by EPA 6000/7000 Series Methods
Mercury	**0.92**		**0.13**	mg/kg dry	B4J0034	10/07/04	10/07/04	7473/SOP535
% Solids	**19**			%	B4J0050	10/11/04	10/12/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/13/04 15:10
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 10/07/04	
Batch B4J0034 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4J0034-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4J0034-DUP1)	**Source: 0409027-23**									
Mercury	1.8		0.12	mg/kg dry		1.9			5	20
Duplicate (B4J0034-DUP2)	**Source: 0409027-35**									
Mercury	0.78		0.14	mg/kg dry		0.77			1	20
Reference (B4J0034-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4J0034-SRM2)										
Mercury	0.47		0.025	mg/kg wet	0.433		109	80-120		
									Prepared: 10/11/04 Analyzed: 10/12/04	
Batch B4J0050 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4J0050-BLK1)										
% Solids	0			%						
Duplicate (B4J0050-DUP1)	**Source: 0409027-23**									
% Solids	20			%		20			0	20

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252B
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/13/04 15:10
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252C

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252C
Reported: 10/06/04 10:49

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
AR-01	0409028-01	Tissue	09/01/04 09:00	09/08/04 19:30
AR-02	0409028-02	Tissue	09/01/04 09:00	09/08/04 19:30
AR-03	0409028-03	Tissue	09/01/04 09:00	09/08/04 19:30
AR-04	0409028-04	Tissue	09/01/04 09:00	09/08/04 19:30
AR-05	0409028-05	Tissue	09/01/04 09:00	09/08/04 19:30
AR-06	0409028-06	Tissue	09/01/04 09:00	09/08/04 19:30
AR-07	0409028-07	Tissue	09/01/04 09:00	09/08/04 19:30
AR-08	0409028-08	Tissue	09/01/04 09:00	09/08/04 19:30
AR-09	0409028-09	Tissue	09/01/04 09:00	09/08/04 19:30
AR-10	0409028-10	Tissue	09/01/04 09:00	09/08/04 19:30
AR-11	0409028-11	Tissue	09/01/04 09:00	09/08/04 19:30
AR-12	0409028-12	Tissue	09/01/04 09:00	09/08/04 19:30
AR-13	0409028-13	Tissue	09/01/04 09:00	09/08/04 19:30
AR-14	0409028-14	Tissue	09/01/04 09:00	09/08/04 19:30
AR-15	0409028-15	Tissue	09/01/04 09:00	09/08/04 19:30
AR-16	0409028-16	Tissue	09/01/04 09:00	09/08/04 19:30
AR-17	0409028-17	Tissue	09/01/04 09:00	09/08/04 19:30
AR-18	0409028-18	Tissue	09/01/04 09:00	09/08/04 19:30
AR-19	0409028-19	Tissue	09/01/04 09:00	09/08/04 19:30
AR-20	0409028-20	Tissue	09/01/04 09:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 10:49
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409028-01**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-01**								Metals by EPA 6000/7000 Series Methods
Mercury	**22**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**23**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-02**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-02**								Metals by EPA 6000/7000 Series Methods
Mercury	**16**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-03**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-03**								Metals by EPA 6000/7000 Series Methods
Mercury	**22**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-04**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-04**								Metals by EPA 6000/7000 Series Methods
Mercury	**23**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-05**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-05**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-06**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-06**								Metals by EPA 6000/7000 Series Methods
Mercury	**25**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-07**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-07**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-08**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-08**								Metals by EPA 6000/7000 Series Methods
Mercury	**18**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-09**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-09**								Metals by EPA 6000/7000 Series Methods
Mercury	**17**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 10:49
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409028-10**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-10**								Metals by EPA 6000/7000 Series Methods
Mercury	**21**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-11**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-11**								Metals by EPA 6000/7000 Series Methods
Mercury	**14**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-12**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-12**								Metals by EPA 6000/7000 Series Methods
Mercury	**35**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-13**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-13**								Metals by EPA 6000/7000 Series Methods
Mercury	**25**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-14**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-14**								Metals by EPA 6000/7000 Series Methods
Mercury	**18**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-15**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-15**								Metals by EPA 6000/7000 Series Methods
Mercury	**12**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-16**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-16**								Metals by EPA 6000/7000 Series Methods
Mercury	**9.8**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-17**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-17**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-18**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-18**								Metals by EPA 6000/7000 Series Methods
Mercury	**26**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 10:49
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409028-19**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-19**								Metals by EPA 6000/7000 Series Methods
Mercury	**12**		**0.12**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**21**			%	B4I0153	09/29/04	09/30/04	% calculation
Lab ID: **0409028-20**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-20**								Metals by EPA 6000/7000 Series Methods
Mercury	**15**		**0.11**	mg/kg dry	B4I0143	09/28/04	09/28/04	7473/SOP535
% Solids	**22**			%	B4I0153	09/29/04	09/30/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 10:49
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 09/28/04	
Batch B4I0143 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4I0143-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4I0143-DUP1)	**Source: 0409028-02**									
Mercury	17		0.11	mg/kg dry		16			6	20
Duplicate (B4I0143-DUP2)	**Source: 0409028-12**									
Mercury	35		0.12	mg/kg dry		35			0	20
Reference (B4I0143-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4I0143-SRM3)										
Mercury	0.48		0.025	mg/kg wet	0.433		111	80-120		
									Prepared: 09/29/04 Analyzed: 09/30/04	
Batch B4I0153 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4I0153-BLK1)										
% Solids	0			%						
Duplicate (B4I0153-DUP1)	**Source: 0409028-01**									
% Solids	22			%		23			4	20

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/06/04 10:49
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252C

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252C
Reported: 10/14/04 10:27

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
AR-21	0409028-21	Tissue	09/01/04 09:00	09/08/04 19:30
AR-22	0409028-22	Tissue	09/01/04 09:00	09/08/04 19:30
AR-23	0409028-23	Tissue	09/01/04 09:00	09/08/04 19:30
AR-24	0409028-24	Tissue	09/01/04 09:00	09/08/04 19:30
AR-25	0409028-25	Tissue	09/01/04 09:00	09/08/04 19:30
AR-26	0409028-26	Tissue	09/01/04 09:00	09/08/04 19:30
AR-27	0409028-27	Tissue	09/01/04 09:00	09/08/04 19:30
AR-28	0409028-28	Tissue	09/01/04 09:00	09/08/04 19:30
AR-29	0409028-29	Tissue	09/01/04 09:00	09/08/04 19:30
AR-30	0409028-30	Tissue	09/01/04 09:00	09/08/04 19:30
AR-31	0409028-31	Tissue	09/01/04 09:00	09/08/04 19:30
AR-32	0409028-32	Tissue	09/01/04 09:00	09/08/04 19:30
AR-33	0409028-33	Tissue	09/01/04 09:00	09/08/04 19:30
AR-34	0409028-34	Tissue	09/01/04 09:00	09/08/04 19:30
AR-35	0409028-35	Tissue	09/01/04 09:00	09/08/04 19:30
AR-36	0409028-36	Tissue	09/01/04 09:00	09/08/04 19:30
AR-37	0409028-37	Tissue	09/01/04 09:00	09/08/04 19:30
AR-38	0409028-38	Tissue	09/01/04 09:00	09/08/04 19:30
AR-39	0409028-39	Tissue	09/01/04 09:00	09/08/04 19:30
AR-40	0409028-40	Tissue	09/01/04 09:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252C
Reported: 10/14/04 10:27

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409028-21**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-21**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.2**		**0.13**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**19**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-22**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-22**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.2**		**0.14**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**18**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-23**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-23**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.3**		**0.14**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**18**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-24**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-24**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-25**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-25**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.2**		**0.11**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**22**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-26**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-26**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-27**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-27**								Metals by EPA 6000/7000 Series Methods
Mercury	**7.3**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-28**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-28**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.3**		**0.13**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**19**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: **0409028-29**								Tissue - Sampled: 09/01/04 09:00
Sample ID: **AR-29**								Metals by EPA 6000/7000 Series Methods
Mercury	**6.3**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 10:27
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409028-30								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-30								Metals by EPA 6000/7000 Series Methods
Mercury	**3.7**		**0.13**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**19**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-31								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-31								Metals by EPA 6000/7000 Series Methods
Mercury	**7.1**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-32								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-32								Metals by EPA 6000/7000 Series Methods
Mercury	**3.3**		**0.14**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**18**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-33								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-33								Metals by EPA 6000/7000 Series Methods
Mercury	**6.0**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-34								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-34								Metals by EPA 6000/7000 Series Methods
Mercury	**5.8**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-35								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-35								Metals by EPA 6000/7000 Series Methods
Mercury	**4.2**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-36								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-36								Metals by EPA 6000/7000 Series Methods
Mercury	**5.5**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-37								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-37								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**21**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-38								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-38								Metals by EPA 6000/7000 Series Methods
Mercury	**4.6**		**0.13**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**19**			%	B4J0058	10/12/04	10/13/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 10:27
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409028-39								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-39								Metals by EPA 6000/7000 Series Methods
Mercury	**3.9**		**0.12**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**20**			%	B4J0058	10/12/04	10/13/04	% calculation
Lab ID: 0409028-40								Tissue - Sampled: 09/01/04 09:00
Sample ID: AR-40								Metals by EPA 6000/7000 Series Methods
Mercury	**3.7**		**0.13**	mg/kg dry	B4J0049	10/11/04	10/11/04	7473/SOP535
% Solids	**19**			%	B4J0058	10/12/04	10/13/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 10:27
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
										Prepared & Analyzed: 10/11/04
Batch B4J0049 - - General Metals - Mercury										Metals by EPA 6000/7000 Series Methods - Quality Control
Blank (B4J0049-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4J0049-DUP1)	**Source: 0409028-30**									
Mercury	3.9		0.13	mg/kg dry		3.7			5	20
Duplicate (B4J0049-DUP2)	**Source: 0409028-33**									
Mercury	5.8		0.12	mg/kg dry		6.0			3	20
Reference (B4J0049-SRM1)										
Mercury	1.0		0.025	mg/kg wet	1.04		96	80-120		
Reference (B4J0049-SRM2)										
Mercury	0.47		0.025	mg/kg wet	0.433		109	80-120		
										Prepared: 10/12/04 Analyzed: 10/13/04
Batch B4J0058 - - General Inorganic - Solids, Dry Weight										Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
Blank (B4J0058-BLK1)										
% Solids	0			%						
Duplicate (B4J0058-DUP1)	**Source: 0409028-37**									
% Solids	21			%		21			0	20

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252C
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/14/04 10:27
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252D

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252D
Reported: 10/07/04 13:39

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
GR-01	0409029-01	Tissue	09/08/04 10:00	09/08/04 19:30
GR-02	0409029-02	Tissue	09/08/04 10:00	09/08/04 19:30
GR-03	0409029-03	Tissue	09/08/04 10:00	09/08/04 19:30
GR-04	0409029-04	Tissue	09/08/04 10:00	09/08/04 19:30
GR-05	0409029-05	Tissue	09/08/04 10:00	09/08/04 19:30
GR-06	0409029-06	Tissue	09/08/04 10:00	09/08/04 19:30
GR-07	0409029-07	Tissue	09/08/04 10:00	09/08/04 19:30
GR-08	0409029-08	Tissue	09/08/04 10:00	09/08/04 19:30
GR-09	0409029-09	Tissue	09/08/04 10:00	09/08/04 19:30
GR-10	0409029-10	Tissue	09/08/04 10:00	09/08/04 19:30
GR-11	0409029-11	Tissue	09/08/04 10:00	09/08/04 19:30
GR-12	0409029-12	Tissue	09/08/04 10:00	09/08/04 19:30
GR-13	0409029-13	Tissue	09/08/04 10:00	09/08/04 19:30
GR-14	0409029-14	Tissue	09/08/04 10:00	09/08/04 19:30
GR-15	0409029-15	Tissue	09/08/04 10:00	09/08/04 19:30
GR-16	0409029-16	Tissue	09/08/04 10:00	09/08/04 19:30
GR-17	0409029-17	Tissue	09/08/04 10:00	09/08/04 19:30
GR-18	0409029-18	Tissue	09/08/04 10:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:39
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409029-01**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-01**								Metals by EPA 6000/7000 Series Methods
Mercury	**35**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-02**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-02**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-03**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-03**								Metals by EPA 6000/7000 Series Methods
Mercury	**14**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-04**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-04**								Metals by EPA 6000/7000 Series Methods
Mercury	**19**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-05**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-05**								Metals by EPA 6000/7000 Series Methods
Mercury	**19**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**20**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-06**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-06**								Metals by EPA 6000/7000 Series Methods
Mercury	**21**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**20**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-07**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-07**								Metals by EPA 6000/7000 Series Methods
Mercury	**65**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**20**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-08**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-08**								Metals by EPA 6000/7000 Series Methods
Mercury	**47**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-09**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-09**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0168	09/30/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:39
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409029-10**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-10**								Metals by EPA 6000/7000 Series Methods
Mercury	**22**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-11**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-11**								Metals by EPA 6000/7000 Series Methods
Mercury	**36**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-12**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-12**								Metals by EPA 6000/7000 Series Methods
Mercury	**26**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-13**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-13**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-14**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-14**								Metals by EPA 6000/7000 Series Methods
Mercury	**32**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**20**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-15**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-15**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.12**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-16**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-16**								Metals by EPA 6000/7000 Series Methods
Mercury	**26**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-17**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-17**								Metals by EPA 6000/7000 Series Methods
Mercury	**34**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation
Lab ID: **0409029-18**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-18**								Metals by EPA 6000/7000 Series Methods
Mercury	**24**		**0.11**	mg/kg dry	B4I0164	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0168	09/30/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number: R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:39
Project: South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
										Prepared & Analyzed: 09/30/04
Batch B4I0164 - - General Metals - Mercury										Metals by EPA 6000/7000 Series Methods - Quality Control
Blank (B4I0164-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4I0164-DUP1)	**Source: 0409029-07**									
Mercury	65		0.12	mg/kg dry		65			0	20
Duplicate (B4I0164-DUP2)	**Source: 0409029-15**									
Mercury	24		0.12	mg/kg dry		24			0	20
Reference (B4I0164-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4I0164-SRM2)										
Mercury	0.46		0.025	mg/kg wet	0.433		106	80-120		
										Prepared: 09/30/04 Analyzed: 10/01/04
Batch B4I0168 - - General Inorganic - Solids, Dry Weight										Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control
Blank (B4I0168-BLK1)										
% Solids	0			%						
Duplicate (B4I0168-DUP1)	**Source: 0409029-08**									
% Solids	21			%		21			0	20
Duplicate (B4I0168-DUP2)	**Source: 0409029-11**									
% Solids	21			%		21			0	20

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:39
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252D

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252D
Reported: 10/14/04 17:26

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
GR-21	0409029-19	Tissue	09/08/04 10:00	09/08/04 19:30
GR-22	0409029-20	Tissue	09/08/04 10:00	09/08/04 19:30
GR-23	0409029-21	Tissue	09/08/04 10:00	09/08/04 19:30
GR-24	0409029-22	Tissue	09/08/04 10:00	09/08/04 19:30
GR-25	0409029-23	Tissue	09/08/04 10:00	09/08/04 19:30
GR-26	0409029-24	Tissue	09/08/04 10:00	09/08/04 19:30
GR-27	0409029-25	Tissue	09/08/04 10:00	09/08/04 19:30
GR-28	0409029-26	Tissue	09/08/04 10:00	09/08/04 19:30
GR-29	0409029-27	Tissue	09/08/04 10:00	09/08/04 19:30
GR-30	0409029-28	Tissue	09/08/04 10:00	09/08/04 19:30
GR-31	0409029-29	Tissue	09/08/04 10:00	09/08/04 19:30
GR-32	0409029-30	Tissue	09/08/04 10:00	09/08/04 19:30
GR-33	0409029-31	Tissue	09/08/04 10:00	09/08/04 19:30
GR-34	0409029-32	Tissue	09/08/04 10:00	09/08/04 19:30
GR-35	0409029-33	Tissue	09/08/04 10:00	09/08/04 19:30
GR-36	0409029-34	Tissue	09/08/04 10:00	09/08/04 19:30
GR-37	0409029-35	Tissue	09/08/04 10:00	09/08/04 19:30
GR-38	0409029-36	Tissue	09/08/04 10:00	09/08/04 19:30
GR-39	0409029-37	Tissue	09/08/04 10:00	09/08/04 19:30
GR-40	0409029-38	Tissue	09/08/04 10:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 17:26
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409029-19**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-21**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.3**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-20**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-22**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.4**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**20**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-21**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-23**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.0**		**0.14**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**18**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-22**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-24**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.5**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**20**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-23**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-25**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.7**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**20**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-24**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-26**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.6**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**20**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-25**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-27**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.5**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-26**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-28**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.0**		**0.16**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**16**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-27**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-29**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.7**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 17:26
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409029-28**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-30**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**20**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-29**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-31**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.0**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**21**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-30**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-32**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.8**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**21**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-31**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-33**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.4**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-32**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-34**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.3**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**21**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-33**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-35**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.1**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-34**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-36**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.1**		**0.12**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**21**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-35**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-37**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.1**		**0.16**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**16**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: **0409029-36**								Tissue - Sampled: 09/08/04 10:00
Sample ID: **GR-38**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.3**		**0.11**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**22**			%	B4J0064	10/13/04	10/14/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 17:26
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409029-37								Tissue - Sampled: 09/08/04 10:00
Sample ID: GR-39								Metals by EPA 6000/7000 Series Methods
Mercury	**5.3**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation
Lab ID: 0409029-38								Tissue - Sampled: 09/08/04 10:00
Sample ID: GR-40								Metals by EPA 6000/7000 Series Methods
Mercury	**4.7**		**0.13**	mg/kg dry	B4J0054	10/12/04	10/12/04	7473/SOP535
% Solids	**19**			%	B4J0064	10/13/04	10/14/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela	**Northern California Office**	**SDG:** 04252D	
Project Number: R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 17:26	
Project: South Bay Mercury TMDL	**San Francisco CA, 94105**		

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 10/12/04	
Batch B4J0054 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4J0054-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4J0054-DUP1)	**Source: 0409029-25**									
Mercury	3.7		0.13	mg/kg dry		3.5			6	20
Duplicate (B4J0054-DUP2)	**Source: 0409029-34**									
Mercury	3.9		0.12	mg/kg dry		4.1			5	20
Reference (B4J0054-SRM1)										
Mercury	1.2		0.025	mg/kg wet	1.04		115	80-120		
Reference (B4J0054-SRM2)										
Mercury	0.44		0.025	mg/kg wet	0.433		102	80-120		
									Prepared: 10/13/04 Analyzed: 10/14/04	
Batch B4J0064 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4J0064-BLK1)										
% Solids	0			%						
Duplicate (B4J0064-DUP1)	**Source: 0409029-21**									
% Solids	18			%		18			0	20

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252D
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/14/04 17:26
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252E

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela
Project Number: R04W05
Project: South Bay Mercury TMDL

Northern California Office
75 Hawthorne Street
San Francisco CA, 94105

SDG: 04252E
Reported: 10/07/04 13:40

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
LR-01	0409030-01	Tissue	09/08/04 15:00	09/08/04 19:30
LR-02	0409030-02	Tissue	09/08/04 15:00	09/08/04 19:30
LR-03	0409030-03	Tissue	09/08/04 15:00	09/08/04 19:30
LR-04	0409030-04	Tissue	09/08/04 15:00	09/08/04 19:30
LR-05	0409030-05	Tissue	09/08/04 15:00	09/08/04 19:30
LR-06	0409030-06	Tissue	09/08/04 15:00	09/08/04 19:30
LR-07	0409030-07	Tissue	09/08/04 15:00	09/08/04 19:30
LR-08	0409030-08	Tissue	09/08/04 15:00	09/08/04 19:30
LR-09	0409030-09	Tissue	09/08/04 15:00	09/08/04 19:30
LR-10	0409030-10	Tissue	09/08/04 15:00	09/08/04 19:30
LR-11	0409030-11	Tissue	09/08/04 15:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:40
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409030-01**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-01**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.2**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-02**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-02**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.5**		**0.12**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-03**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-03**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.9**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-04**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-04**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.3**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-05**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-05**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.2**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-06**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-06**								Metals by EPA 6000/7000 Series Methods
Mercury	**4.6**		**0.12**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**21**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-07**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-07**								Metals by EPA 6000/7000 Series Methods
Mercury	**3.5**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-08**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-08**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.4**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: **0409030-09**								Tissue - Sampled: 09/08/04 15:00
Sample ID: **LR-09**								Metals by EPA 6000/7000 Series Methods
Mercury	**2.5**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:40
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409030-10								Tissue - Sampled: 09/08/04 15:00
Sample ID: LR-10								Metals by EPA 6000/7000 Series Methods
Mercury	**2.2**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation
Lab ID: 0409030-11								Tissue - Sampled: 09/08/04 15:00
Sample ID: LR-11								Metals by EPA 6000/7000 Series Methods
Mercury	**2.0**		**0.11**	mg/kg dry	B4I0160	09/30/04	09/30/04	7473/SOP535
% Solids	**22**			%	B4I0167	09/30/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:40
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 09/30/04	
Batch B4I0160 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4I0160-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4I0160-DUP1)	**Source: 0409030-06**									
Mercury	4.7		0.12	mg/kg dry		4.6			2	20
Duplicate (B4I0160-DUP2)	**Source: 0409030-11**									
Mercury	2.1		0.11	mg/kg dry		2.0			5	20
Reference (B4I0160-SRM1)										
Mercury	1.1		0.025	mg/kg wet	1.04		106	80-120		
Reference (B4I0160-SRM2)										
Mercury	0.43		0.025	mg/kg wet	0.433		99	80-120		
									Prepared: 09/30/04 Analyzed: 10/01/04	
Batch B4I0167 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4I0167-BLK1)										
% Solids	0			%						
Duplicate (B4I0167-DUP1)	**Source: 0409030-03**									
% Solids	22			%		22			0	20
Duplicate (B4I0167-DUP2)	**Source: 0409030-10**									
% Solids	22			%		22			0	20

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252E
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/07/04 13:40
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Qualifiers and Comments

U	Not Detected
NR	Not Reported

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street Building 201

Richmond, CA 94804

Subject: **Analytical Testing Results - Project R04W05**
SDG: 04252A

From: **Brenda Bettencourt, Director**
EPA Region 9 Laboratory
PMD-2

To: **Luisa Valiela**
Northern California Office
WTR-3

Attached are the results from the analysis of samples from the **South Bay Mercury TMDL** project. These data have been reviewed in accordance with EPA Region 9 Laboratory policy.

A full documentation package for these data, including raw data and sample custody documentation, is on file at the EPA Region 9 Laboratory. If you would like to request additional review and/or validation of the data, please contact Vance Fong at the Region 9 Quality Assurance Office.

If you have any questions, please ask for Richard Bauer, the Lab Project Manager at (510)412-2300.

Analyses included in this report:

Mercury	Solids, Dry Weight

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela	**Northern California Office**	**SDG:** 04252A	
Project Number: R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 11:03	
Project: South Bay Mercury TMDL	**San Francisco CA, 94105**		

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Collected	Date Received
LA-01	0409026-01	Tissue	08/31/04 13:00	09/08/04 19:30
LA-02	0409026-02	Tissue	08/31/04 13:00	09/08/04 19:30
LA-03	0409026-03	Tissue	08/31/04 13:00	09/08/04 19:30
LA-04	0409026-04	Tissue	08/31/04 13:00	09/08/04 19:30
LA-05	0409026-05	Tissue	08/31/04 13:00	09/08/04 19:30
LA-06	0409026-06	Tissue	08/31/04 13:00	09/08/04 19:30
LA-07	0409026-07	Tissue	08/31/04 13:00	09/08/04 19:30
LA-08	0409026-08	Tissue	08/31/04 13:00	09/08/04 19:30
LA-09	0409026-09	Tissue	08/31/04 13:00	09/08/04 19:30
LA-10	0409026-10	Tissue	08/31/04 13:00	09/08/04 19:30
LA-11	0409026-11	Tissue	08/31/04 13:00	09/08/04 19:30
LA-12	0409026-12	Tissue	08/31/04 13:00	09/08/04 19:30
LA-13	0409026-13	Tissue	08/31/04 13:00	09/08/04 19:30
LA-14	0409026-14	Tissue	08/31/04 13:00	09/08/04 19:30
LA-15	0409026-15	Tissue	08/31/04 13:00	09/08/04 19:30
LA-16	0409026-16	Tissue	08/31/04 13:00	09/08/04 19:30
LA-17	0409026-17	Tissue	08/31/04 13:00	09/08/04 19:30
LA-18	0409026-18	Tissue	08/31/04 13:00	09/08/04 19:30
LA-19	0409026-19	Tissue	08/31/04 13:00	09/08/04 19:30
LA-20	0409026-20	Tissue	08/31/04 13:00	09/08/04 19:30

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 11:03
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409026-01**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-01**								Metals by EPA 6000/7000 Series Methods
Mercury	**18**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-02**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-02**								Metals by EPA 6000/7000 Series Methods
Mercury	**12**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**20**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-03**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-03**								Metals by EPA 6000/7000 Series Methods
Mercury	**7.9**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-04**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-04**								Metals by EPA 6000/7000 Series Methods
Mercury	**8.4**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-05**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-05**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.3**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-06**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-06**								Metals by EPA 6000/7000 Series Methods
Mercury	**6.8**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-07**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-07**								Metals by EPA 6000/7000 Series Methods
Mercury	**8.8**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-08**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-08**								Metals by EPA 6000/7000 Series Methods
Mercury	**8.9**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-09**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-09**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.7**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 11:03
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: **0409026-10**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-10**								Metals by EPA 6000/7000 Series Methods
Mercury	**9.2**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-11**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-11**								Metals by EPA 6000/7000 Series Methods
Mercury	**12**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-12**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-12**								Metals by EPA 6000/7000 Series Methods
Mercury	**13**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-13**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-13**								Metals by EPA 6000/7000 Series Methods
Mercury	**17**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-14**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-14**								Metals by EPA 6000/7000 Series Methods
Mercury	**11**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-15**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-15**								Metals by EPA 6000/7000 Series Methods
Mercury	**5.0**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-16**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-16**								Metals by EPA 6000/7000 Series Methods
Mercury	**14**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-17**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-17**								Metals by EPA 6000/7000 Series Methods
Mercury	**15**		**0.11**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**22**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: **0409026-18**								Tissue - Sampled: 08/31/04 13:00
Sample ID: **LA-18**								Metals by EPA 6000/7000 Series Methods
Mercury	**13**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:** 04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 11:03
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**	

Sample Results

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Batch	Prepared	Analyzed	Method
Lab ID: 0409026-19								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-19								Metals by EPA 6000/7000 Series Methods
Mercury	**12**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**20**			%	B4I0157	09/29/04	10/01/04	% calculation
Lab ID: 0409026-20								Tissue - Sampled: 08/31/04 13:00
Sample ID: LA-20								Metals by EPA 6000/7000 Series Methods
Mercury	**10**		**0.12**	mg/kg dry	B4I0148	09/29/04	09/29/04	7473/SOP535
% Solids	**21**			%	B4I0157	09/29/04	10/01/04	% calculation

United States Environmental Protection Agency
Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager: Luisa Valiela	**Northern California Office**	**SDG:** 04252A	
Project Number: R04W05	**75 Hawthorne Street**	**Reported:** 10/06/04 11:03	
Project: South Bay Mercury TMDL	**San Francisco CA, 94105**		

R9

Quality Control

Analyte	Result	Qualifiers / Comments	Quantitation Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit
									Prepared & Analyzed: 09/29/04	
Batch B4I0148 - - General Metals - Mercury									Metals by EPA 6000/7000 Series Methods - Quality Control	
Blank (B4I0148-BLK1)										
Mercury	ND	U	0.025	mg/kg wet						
Duplicate (B4I0148-DUP1)	**Source: 0409026-06**									
Mercury	6.7		0.11	mg/kg dry		6.8			1	20
Duplicate (B4I0148-DUP2)	**Source: 0409026-20**									
Mercury	10		0.12	mg/kg dry		10			0	20
Reference (B4I0148-SRM1)										
Mercury	1.2		0.025	mg/kg wet	1.04		115	80-120		
Reference (B4I0148-SRM2)										
Mercury	0.46		0.025	mg/kg wet	0.433		106	80-120		
									Prepared: 09/29/04 Analyzed: 10/01/04	
Batch B4I0157 - - General Inorganic - Solids, Dry Weight									Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control	
Blank (B4I0157-BLK1)										
% Solids	0			%						
Duplicate (B4I0157-DUP1)	**Source: 0409026-07**									
% Solids	21			%		22			5	20
Duplicate (B4I0157-DUP2)	**Source: 0409026-14**									
% Solids	21			%		21			0	20

United States Environmental Protection Agency

Region 9 Laboratory

1337 S. 46th Street, Building 201, Richmond, CA 94804
Phone:(510) 412-2300 Fax:(510) 412-2302

Project Manager:	Luisa Valiela	**Northern California Office**	**SDG:**	04252A
Project Number:	R04W05	**75 Hawthorne Street**	**Reported:**	10/06/04 11:03
Project:	South Bay Mercury TMDL	**San Francisco CA, 94105**		

Qualifiers and Comments

U	Not Detected
NR	Not Reported